IRON AND STEEL ENGINEER

J. F. KELLY, Editor

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MEETINGS AND PAPERS

PITTSBURGH SECTION

R. F. Chaffin, Chairman J. F. Kelly, Secretary

Saturday, January 15th, 1927

Blue Room, Wm. Penn Hotel.

Dinner 6:30 P. M. Technical Session 8:00 P. M.

Subject:

"Ductless Electric Power Cables," by C. F. Hood, Operating Supt., American Steel & Wire Company, Cleveland, Ohio. Paper will be illustrated by moving pictures.

Saturday, February 19th, 1927

Blue Room, Wm. Penn Hotel.

Dinner 6:30 P. M. Technical Session 8:00 P. M.

Subject:

"Turbines," by Mr. H. W. Pragst, Engineer, General Electric Company, Schenectady, New York.

Saturday, March 19th, 1927

Blue Room, Wm. Penn Hotel.

Dinner 6:30 P. M. Technical Session 8:00 P. M.

Subject:

"Power Factor Correction," by D. H. Feldman, Engineer, Electric Machinery Manufacturing Company, Minneapolis, Minn.

PHILADELPHIA SECTION

Saturday, January 8th, 1927

"Electrification of Boiler House Auxiliaries," by F. T. Leilach, Engineer, Consolidated Gas, Electric Light & Power Company of Baltimore, Baltimore, Md.

Saturday, February 5th, 1927

"Experimental Talk on Electricity, Use of Mechanical Ideas in Electricity and Magnetism," by Dr. Benjamin Franklin, Prof. Elec. Engineering, Massachusetts Institute of Technology, Boston, Mass.

Saturday, March 5th, 1927

"A Symposium, the Parallel Operation of Motor Generator Sets, Rotary Converters and Rectifiers." To be handled by D. M. Petty, Elec. Supt., Bethlehem Steel Company, Bethlehem, Pa.

All meetings, unless otherwise noted, will be held at the Engineers' Club, 1317 Spruce Street, and will start promptly at 7:30 P. M. Dinner at 6:00 P. M.

Chairmen and Secretaries

Section	Chairman	Secretary
Philadelphia	F. O. Schnure	Linn O. Morrow
Cleveland	A. L. Reichert	A. R. Lintern
Chicago	Elbert Lewis	Gordon Fox
Pittsburgh	R. F. Chaffin	John F. Kelly
Birmingham	W. W. Garrett	J. E. Sayer

EDITORIALS

Many members of our Association of Iron and Steel Electrical Engineers and the readers of Iron and Steel Engineer have requested that we prepare a booklet showing the different specifications adopted by our Society; and incorporate with this any lists which might be used as a reference for the guidance of those engineers whose duties require the securing of information covering periods from the beginning of the electrification of the industry to the present time. No more valuable lists could have been compiled than those known as "List of Main Roll Drives in the United States and Canada" and "Twenty year index of papers presented before the Association of Iron and Steel Electrical Engineers at Birmingham, Philadelphia, Chicago, Cleveland and Pittsburgh Sections and those presented at the annual conventions."

The specifications along with the lists will form the editorial matter of our January, 1927, issue, the contents of which will be:

General Specifications for Electric Overhead Traveling Cranes Heavy Duty Steel Mill Service.

These specifications are used by the Iron and Steel Industry and the Crane Builders.

General Specifications for A.C. Motors and Main Roll Drives.

These specifications are used by the Iron and Steel Industry and by the Electrical Manufacturers.

List of Main Roll Drives in the United States and Canada.

Prepared with the view of providing the executives and engineers with an authoritative reference, for their guidance in future installations and extensions. The list gives the Horsepower, R.P.M., Voltage, Cycles, Type and Size of Mill, Method of Drive, date of purchase, name of plant and location. Also a classified list which gives the types of installations in Blooming Mills, Plate Mills, Rail and Structural Mills, Bar and Billet Mills, Sheet Bar and Skelp Mills, Sheet and Tin Plate Plants, Rod Mills, Piercing Mills, Tube Mills, Strip and Hoop Mills, Merchant Mills, Wire Mills, Wheel Mills, Aluminum, Brass, Cooper and Non Ferrous Mills, also the Multi Speed Drives, A.C. Speed Sets, Direct Current Adjustable Speed Drives and Reversing Blooming-Mill Drives.

The Standardized Commutating Pole Mill Type Motor.

Adopted by the Iron and Steel Industry and the Electrical Manufacturers. Through the concerted efforts of the executives and engineers of the Iron and Steel Industry and the Electrical Manufacturers a standardized commutating pole mill type motor has been designed and adopted for use in the Iron and Steel Industry. A chart showing the dimensions as well as explanations for its use will be given.

General Specifications for Construction and Installation of Automatic Engine Stops.

Prepared by the Safety Committee of the A. I. & S. E. E., for use in the Steel Industry.

Rules for the Safe Operation of Electric Overhead Traveling Cranes.

Recommended by the A. I. & S. E. E., for use in the Iron and Steel Industry.

Twenty-year Index of Papers Presented Before the Association of Iron and Steel Electrical Engineers at Birmingham, Philadelphia, Chicago, Cleveland and Pittsburgh District Sections and Those Presented at the Annual Conventions.

This index will be one of the most valuable pieces of engineering literature for use of the operating and producing heads in the Iron and Steel Industry. The index represents twenty years of engineering service rendered to the Iron and Steel Industry by the A. I. & S. E. E. The index is compiled first under subject, second authors, third costs, fourth charts and tables.

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Bethlehem Steel Company's New Gautier Mills From a Safety Standpoint

By JOHN NORTHWOOD*

IN designing and laying out our new Gautier Mills the question of Safety was a very important consideration and every detail was worked out very carefully so that the mills could be operated with maximum production and safety as far as Engineering ability could devise.

Due to the number and close juxtaposition of mills to be installed, safe walkways from mill to mill were a first consideration. These were provided by a series of concrete subways leading from the entrance gate to all the mills with stairways leading to and from each mill. Stairways and subways were also installed under railroad tracks in such a way that all hazards of grade crossings were eliminated. All these subway are well lighted and well ventilated.

FIG. 1—Stairway with flute along edge for drainage and cleaning.

One noteworthy feature of the stairways leading to the subway is a groove 2½" wide between the wall and steps on each side of stairs to prevent dirt from accumulating in the corners.

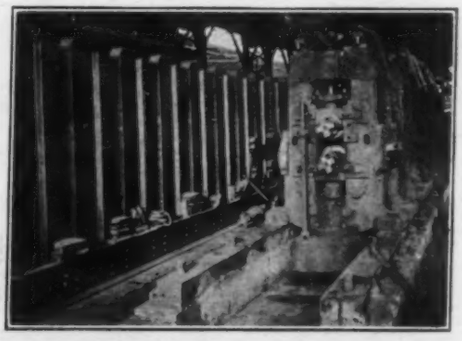


FIG. 2.—Roll racks and roll pit for assembling a set of rolls as a unit, to be moved into position by crane.

The buildings are all large and afford plenty of light and fresh air. The electric lights in the buildings are on a circuit separate from the mill circuit and lighting has been given special consideration. The excellent illumination and ventilation of these buildings are undoubted aids to the Safety of the employees.

Circuit breakers are used thruout the mills, even in the cranes, eliminating troublesome fuses.

Toilet and locker rooms have been provided at each mill and the convenience of the men has been carefully considered in their location. They are kept clean by a janitor who is on the job continously.

Specially designed stands for the storing of spare rolls, with racks for the storing of guides and fittings have been provided at each mill making it possible for the men to keep the mills tidy and clean as well as easy of access. This, of course, teaches them the value of good housekeeping which in itself is one of the first rules of Safety.

FIG. 3—Heat screen for protection of men working along hot run.

In all the new mills the housings and rolls for the next roll change are set up over a pit which makes it very easy for our workmen to set them up successfully. They are moved as a unit when necessary.

The mechanically operated system of feeding material into the furnace after the crane has lowered the lift onto the feed bed is another outstanding feature which has eliminated a number of sprained backs that were common in the old manner of handling this stock.

Snubbing or turtle back posts have been installed in the mills to prevent the tail end of the

*Supt. Safety Dept., Bethlehem Steel Co., Johnstown, Pa.

hot looping bars from striking the operator while he is feeding the mill.

All the spindles in the mills are covered with steel guards to protect the workmen from being caught. Where it is necessary for a man to walk over these spindles, steel stairways with standard hand railings have been provided.

FIG. 4—Spindle guard, walkway over housings and operator's pulpit.

Heat screens have been installed at various points along the hot beds behind which Rollers can stand while gauging or turning bars.

The operator's pulpits have been enclosed with steel sides and roof as far as possible to protect the operator from both heat and danger in case of cobbles.

A circulating system in which oil is pumped from the central oiling station does away with

FIG. 5—Automatic device for turning hot billets on edge after passing through rolls.

Oilers to a great extent. This system permits the oil to be used over and over again after cleaning and eliminates the waste of oil and in addition promotes cleaniness around the mills.

All our furnaces burn our Coke Plant gas piped for a distance of about three miles. This fuel has many advantages over the old coal firing, both from an efficiency and cleanliness standpoint. These lines are well equipped with floating type gas pressure regulators that prevent excessive gas pressure being built up at the furnace thus eliminating the hazard of gas explosions.

At two of our mills we have installed mechanical devices for edging blooms just after they pass thru the first roughing rolls. This eliminates turning by hand with tongs, an extremely hot job.

Cast iron plates roughed to prevent slipping have been used on all openings between mill tables.

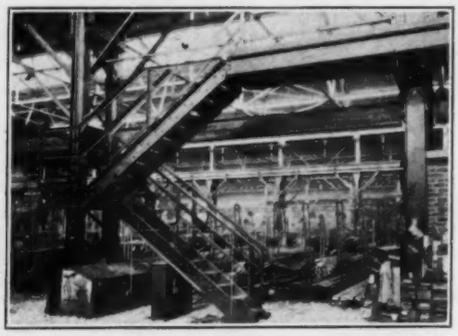


FIG. 6—Stairway leading to crane operator's platform.

Concrete pits have been installed under all hot beds which afford safe and easy access for maintenance and repairs.

From an electrical standpoint means of accident prevention have been provided. All wiring has been placed in conduits. All mechanical control boards have been elevated about 8 ft. high and provided with stairways and platforms leading to them. This prevents passers-by and unauthorized from tampering with them or from being affected by flashes while operating.

FIG. 7—Cradles used in piling billets for safety and accessibility.

All motor houses are locked and only Electrical Department men have keys. This insures, if anything should go wrong, that no one except an electrically trained man can make repairs.

At each mill a single pole safety switch has been installed on mill operating board so that while men are working on the mill it cannot be operated until

operator puts in this control switch. This eliminates the danger of starting the motor while men are working on the mill.

A bus bar installation running from generating station to mill motors passes thru a 6 ft. concrete conduit eliminating many hazards and making it very accessible for repairs.

Standard stairways leading to crane cages and repair platforms have been provided at all cranes, making access to cages easy and safe.

Cranes operating in stockyards are of the Morgan type with overhung drum and with but one motor, which makes it unnecessary to use a spreader even in the handling of 30 ft. length billets. Cradles are used in stockyard separating billets, allowing 4" space between them, in this way making them very accessible for crane lifts. These cradles of the "U" shape type are also on stock cars in transfering billets from the 18" Mill to the Gautier Plant for further rolling on the new mills. These cradles have eliminated a number of hazards and are a big factor in the safe piling of materials in the stockyard.

Since the beginning of operations in the new Gautier mills, lost time accidents there, both minor and major, have been materially reduced, demonstrating to us that it was worth while to consider safety from every angle in the installation of new equipment, making it as nearly fool-proof as possible.

Electric Furnaces In Manufacturing

By N. R. STANSEL*

THE Chairman of the Electric Heat Committee of the Association of Iron and Steel Electrical Engineers has suggested that a memorandum of the uses of electric heat by manufacturers will be of interests to the members of the Association.

The factories of the General Electric Company are large users of heat. At the Schenectady Works, for example, there are over 3700 applications of heat in manufacturing processes, approximately 2000 of these are electric heat, the remainder being oil, gas, coal and coke burning equipments and steam heat ovens. The Schenectady furnaces include 319 electric furnaces, large and small. The total number of furnaces of all kinds in that plant is 553.

A similar general use of electric heat is found at the other factories. While there is no exact procedure in furnace application followed by each factory, as local conditions at each point must be taken into consideration, the practice in the selection of sources of heat is very much the same at all factories. This is brought about by interchange of data through an Interworks Furnace Committee. Hence, by illustrations of typical electric furnaces in the various factories we can present our general viewpoint regarding the use of electric current as a source of heat.

While this electric furnace equipment includes both the Arc furnace and the Induction furnace, the Resistor type furnace is by far the most general in its application of electric heat to manufacturing processes. For this reason our discussion will be limited to the use of the latter type furnace and further limited to the metallic resistor furnace, which uses the nickel-chromium alloy heating element. The temperature range of 750°F. (440°C) to 1850°F. (1010°C) represents the field of this type of furnace and within this range of temperature lie practically all standard furnace operation except the melting of ferrous metals and of some non-ferrous metals, the forging of iron and steel and the hardening of high speed steel.

*Industrial Engineering Dept., General Electric Company, Schenectady, N. Y.

Between the two temperatures noted there are two distinct uses of furnaces:

(a) Heating only.

(b) Heat Treatment processes.

For heating only, fuel is the general economic source of heat. In this class we find that, as a rule, quantity, low unit value of product and a minimum amount of skill are the characteristics, so for convenience we designate this class as Bulk heating. As bulk heating becomes a part of manufacturing processes, the factors of convenience, location of operation, hygienic considerations, comfort, safety, etc., become of more and more importance and the cost of the heat units of less importance. When used in manufacturing, bulk heating is usually under automatic temperature control.

By a heat treatment process is meant a heat operation in which an even distribution of temperature and an accurate control of the temperature are vital factors in the use of heat to change the properties of material. Also, in some cases control of the furnace atmosphere is a third factor which is an important consideration.

In heat treatment processes the cost of the heat units is usually a comparatively small item in the cost of production and an economic analysis of a heat treatment operation is not based on the costs of the heat units alone. In such an analysis the cost per unit of output, the quality, the uniformity and the rate of production are the guiding factors in the selection of heating equipment. Along with these factors go, of course, considerations of first cost, space occupied, maintenance, surrounding conditions and the general effect of the heating equipment upon other operations and expenses of the plant.

Bulk Heating

The aluminum melting furnace shown in Fig. 1 is an example of bulk heating in a manufacturing plant. This installation is in the small motor factory at Lynn, which produces small motors at the rate of 1500 per week, requiring approximately 200 tons of aluminum per annum. The connected load of each

furnace is 32 KW. With a metal temperature of 1310°F. (710°C) the rate of melting is approximately 120 pounds per hour.

These furnaces have been in use since July, 1925, and while they show a saving of 85 cents per 100 pounds of aluminum in the melting cost, as compared with the former cost of melting in fuel fired furnaces,

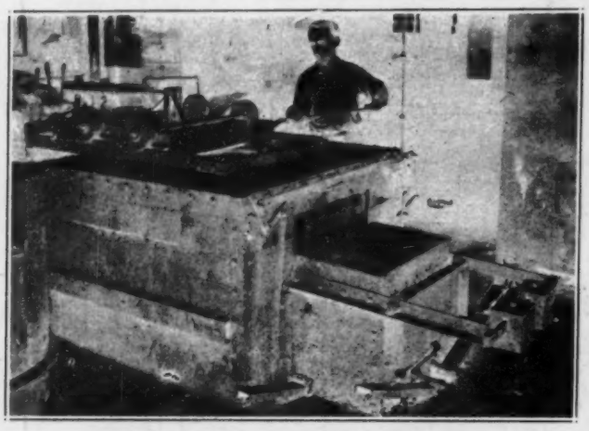


FIG. 1—Aluminum Melting Furnace.

this saving was not the primary reason for the adoption of electric heat. The real advantage gained is the betterment of the working conditions around the furnace location. It is an economic necessity to have this part of the manufacturing directly in the line of production, and the operation of a fuel fired furnace of any kind in that location is very objectionable.

There are many other applications of electric current for bulk heating in our factories but the installation in each case is due to the undesirability of fuel burning in the location, the convenience of electric

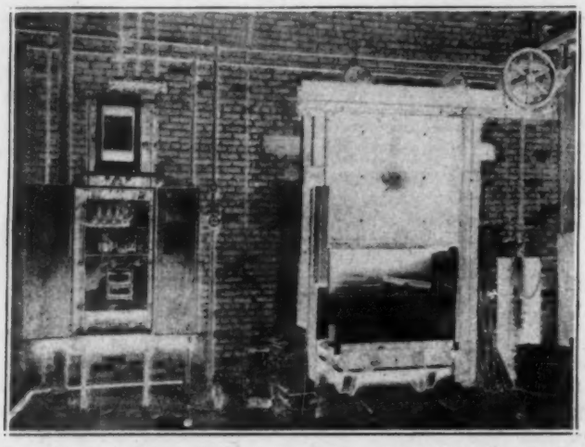


FIG. 2—Car Type Electric Furnace, 120 KW.

heat, cleanliness, etc. Seldom do we find in such cases that the cost of electric heating is greater than would be the cost if a fuel burning furnace were used.

Heat Treatment Processes

The annealing of iron and steel is a heat treatment process that varies widely in its application according to the class of material and service for which it is designed. The annealing furnace must provide for the proper correlation of the rate of heating, the temperature to which the material is heated, the time it is held at the specified temperature, and the rate of cooling. This last condition applying only to material that is cooled within the furnace.

The car bottom electric furnace of Fig. 2 is used at Schenectady for annealing of plates and small and moderate size steel castings, at temperatures around 1562°F. (850°C.) The heating chamber dimensions are: length 6 ft., width 4 ft., height 3 ft. 2 in. This furnace is operated only at night, usually starting at 10 P. M. and running from 10 to 12 hours. At the end of the heating period the charge is removed from the furnace and allowed to cool in the indoor air. No attendance during the night is required.

The space factor is important in the economy of annealing furnaces, particularly where castings are annealed. Castings vary so widely in their weight volume relation that a heating chamber may be completely filled with a comparatively small weight of

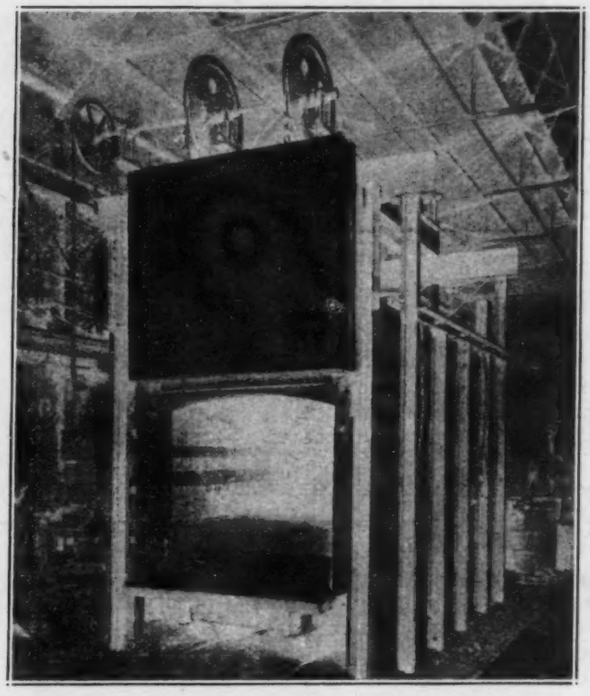


FIG. 3—Car Type Electric Furnace, 200 KW.

hollow castings, or on the other hand not half full with several times that weight. The heat loss through the walls while the furnace is hot is constant, without regard to the content of the furnace, and the less the weight of the charge the greater this loss per pound of material. The same is true as regards the heat stored in the walls, car, supports, etc., which is lost with each cooling.

The furnace of Fig. 2 takes work as it comes and the weights of the daily charges vary from 2500 to 6500 pounds. The heating cycles are fairly uniform and the following tabulation of averages for a period of eight months illustrates the influence of space factor on pounds per kilowatt hour for this furnace.

Weight of Charge	Lbs. per Kilowatt hour
2000	2.0
3000	2.5
4000	3.0
5000	3.5
6000	4.2
6500	4.5

This furnace has been in continuous operation for two years and so far has cost practically nothing for repairs.

The service of the furnace shown in Fig. 3 is annealing high speed steel and steel forgings, the material being cooled in the furnace. A temperature of 1427°F. (775°C) is used. The charge is stacked on open supports, about 7" above the car floor. Only side wall resistors are used. The rate of heating is slow, approximately 12 hours being taken to reach the final temperature as measured by a thermo-couple placed near the center of the charge. This is followed by a "soaking" period, usually about four hours, after which the power is shut off and the charge allowed to cool in place to about room temperature. This is a type of slow cooling furnace, a large part of the energy input of the heat cycle being stored in the

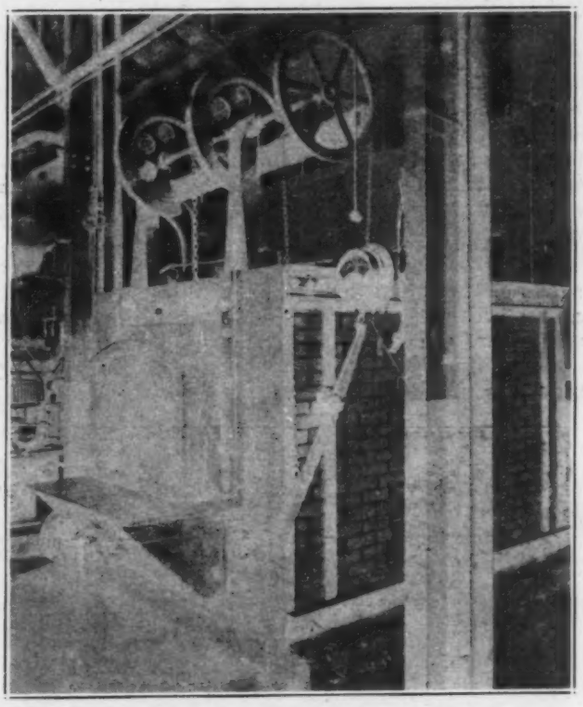


FIG. 4—Box Type Electric Furnace.

walls and car bottom and utilized for controlling the rate of cooling of the charge.

A typical run of this furnace for which the charge was 14 pieces, total weight 7905 lbs., required 2820 kilowatt hours. The space factor was 10 per cent. The labor charge was $1.05, attendance charge $1.00.

The electric furnace was introduced in the shop for heat treatment of gears at the Lynn Works in 1923 This shop is now equipped with rotary type, pit type and box type electric furnaces and in addition has retained a part of the original fuel burning furnace equipment. A part of the electric furnace installation is shown in Figs. 4 and 5.

A change from fuel burning furnaces to electric furnaces is sometimes a period of adjustment. Both mental and physical habits persist and a little time is required before the full advantages of the electric furnace can be realized. The high grade of the product from the electric furnaces in this shop was soon realized and intensive study was given to the application of electric heat to this class of work. The result has been an increasing flow of work through the electric furnace on the basis of both better work, and a reduced cost of production. The marked improvement in working conditions can only be realized by a visit to this shop.

The electric furnace equipment of the general heat treating shop at Schenectady consists of: two 8 ft. by 8 ft. by 2-1-2 ft. box type electric furnaces, 200 KW

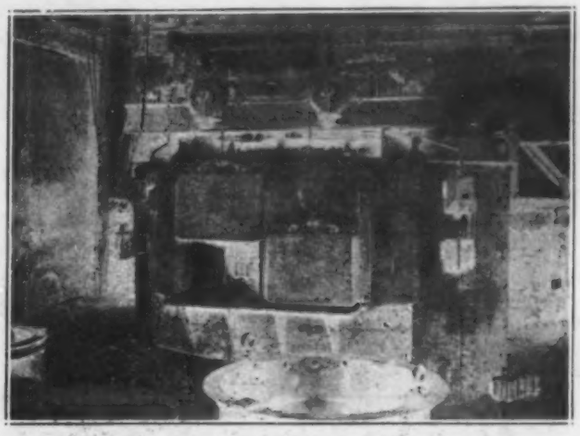


FIG. 5—Rotary Hearth Electric Furnace.

each, three 6 ft. by 6 ft. by 2 ft. electric furnaces, 115 KW each, and two smaller electric furnaces. A part of this furnace equipment is shown in Fig. 6.

The electric furnaces are used for the heat treatment of steam turbine buckets, shafts, machine parts, etc.

A feature of these furnaces not usual in electric furnace construction is the provision of ventilating ducts in the roof and side walls to control the rate of cooling when a charge is cooling in the furnace. By

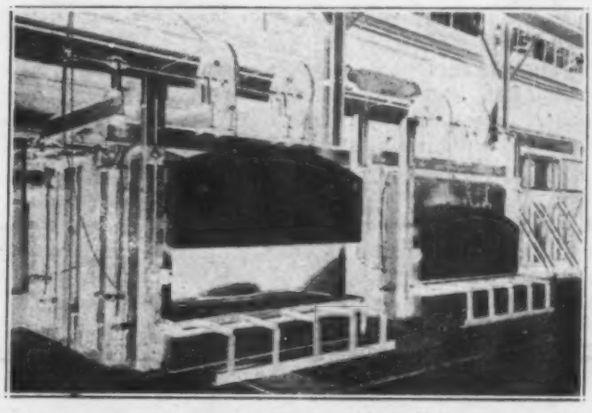


FIG. 6—Electric Furnaces in General Heat Treating Plant.

this provision the engineer in charge of heat treatment processes can specify the rate of cooling as well as other elements of the process.

The electric furnaces in this shop have been in continuous use for three years, at temperatures usually around 1652°F. (900°C.) So far, with the exception of five new alloy hearths, nothing more than minor repairs have been needed. No repairs to either the brickwork or the resistors have been made. A recent

inspection of one of the furnaces showed all parts to be in excellent condition. Barring accidents the resistors are expected to have an indefinite life.

The electric furnaces of the tool and die shop of Building 17 at Schenectady, shown in Fig. 7 have appeared in print more than once. Their continuous service without a shut down since the date of installation, August, 1919, entitles them to a certain amount of respect in the comparatively young life of the electric furnace industry. The service is the heat treatment of tools and dies, plain carbon and carbon-chrome steels.

The heating chamber dimensions are: length 42 in., width 36 in., height 30 in. The connected load of

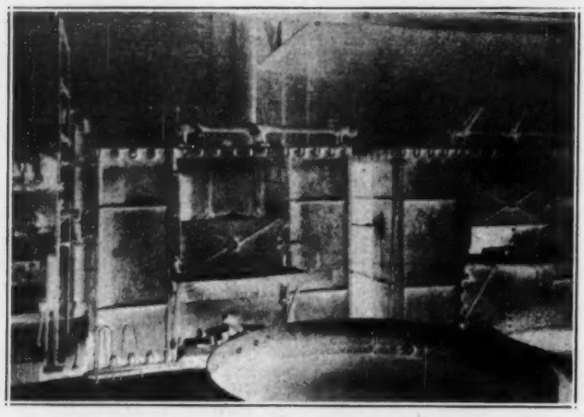


FIG. 7—Early Installation (1919) of Electric Furnaces, 20 KW each.

each furnace is 20 KW. Operating temperatures: Left hand furnace, 1472°F. (800°C.), Right hand furnace, 1112°F. (600°C.) The flow of work is intermittent. Quality of the product is the one essential requirement. The cost of the heat units is a cent or two per pound. The value of the product is many dollars per pound.

These furnaces have averaged around 50,000 pounds of heat treated steel per annum for several years. Up to the present time the only repair work needed for these furnaces has been an occasional repair to the brick hearths, which wear due to the sliding of the charges in and out of the furnaces.

In dealing with furnace problems one cannot, with wisdom, overlook the viewpoint of the operators. The comment of the foremen of this shop regarding his men is: "These men have had a nice, clean, comfortable job so long, and get their work out with so little trouble, that if we were to go back to the old fuel fired furnaces I believe they would quit the job."

The heat treatment of sheet steel, plain carbon and silicon sheets for the betterment of the magnetic properties of the metal, is a process peculiar to the electrical manufacturing industry. The elevator type electric furnace shown in Fig. 8, an installation at the Pittsfield Works, is used for this service.

During the past three years 14 of these furnaces have been placed in service: one at Schenectady, one at Erie, seven at Pittsfield, two at Fort Wayne, one at Lynn, one at Oakland, and one at Toronto. The present plans of factory growth call for five more furnaces of this type. An average size of the heating chamber is: length 10 ft., width 4 ft., height 3 ft. Connected load, average 200 KW. Total connected load about 2500 KW.

The sheets are heat treated at 1412°F. (800°C.) for approximately 12 hours and are then withdrawn from the furnace for cooling. Large sheets must be protected against too rapid cooling, which causes buckling. The smaller sheets, such as small transformer and motor punchings, can be cooled in the open air. An average output of these furnaces is nine pounds per kilowatt hour.

A large saving in the cost of this process, due to the electric furnace, is the elimination of the heavy cast iron containers for the sheets which are necessary with fuel fired furnaces. In addition to the saving in the cost of the containers (which was approximately $2.00 per ton of metal treated in the fuel fired furnaces) there is a considerable saving in the space required for their use.

A detail of the furnaces shown in the illustration is of interest. The cars are equipped with motors. A third rail is used for the current supply. The motors are controlled from a remote control station placed outside of the range of the hot sheets as they come from the furnace so that the operator works in comfort and with little effort. The motors are well protected from the heat by the insulation of the car bottom.

Some twelve years ago the late Dr. Steinmetz, speaking to the Franklin Institute, summarized his analysis of the relation of the use of electric power to industry thus: "The introduction of electric power in place of other forms of power rarely can be a mere substitution but usually requires a change of

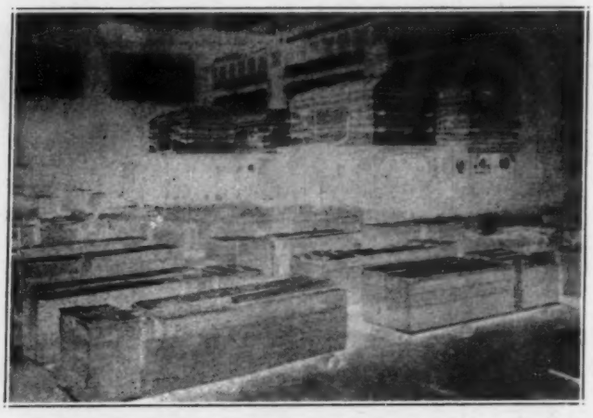


FIG. 8—Elevator Type Electric Furnaces, 130 KW each.

methods of power application, a reorganization of industry, to secure maximum economy." The accuracy of this forecast is now a matter of history. In the use of electric current for heating we are not far away from the position of the electric motor when the economy of individual motor drive began to be appreciated. It may be that we can translate these words of Dr. Steinmetz into guidance towards the third possible large use of electric current in industry.

The heat treatment of metals is an art of long standing and many traditions. The limitations of the fuel fired furnace centralized heat treatment processes. Naturally the electric furnace found its first place in the same shop with fuel fired furnaces and assumed its share of the burden of the movement of material

back and forth. The artisans required for the fuel fired furnaces were assumed to be necessary for the electric furnace. That procedure does not satisfy manufacturing conditions for which the more exact procedure of scientific control is essential.

The electric furnace of Fig. 9 is an installation which represents a reorganization of heat treatment methods. This furnace is placed in the line of manufacturing operations, adjacent to other machinery in the manufacture of radio apparatus. The service of this furnace is hardening magnet steel. Perhaps there is no heat treatment process as precise as this particular operation. A few degrees above or below the prescribed temperature, a too short or too long exposure to the heat, and the steel is unfit for use as a magnet. This furnace and another somewhat larger furnace in the same room are equipped with mechanical feed. The magnets drop from the heating chamber into the quenching bath after a definite time within the furnace. The temperature is under automatic control. The work of the attendant is to take care of the supply and removal of the magnets. For tungsten steel the temperature is 1562°F. (850°C.) For

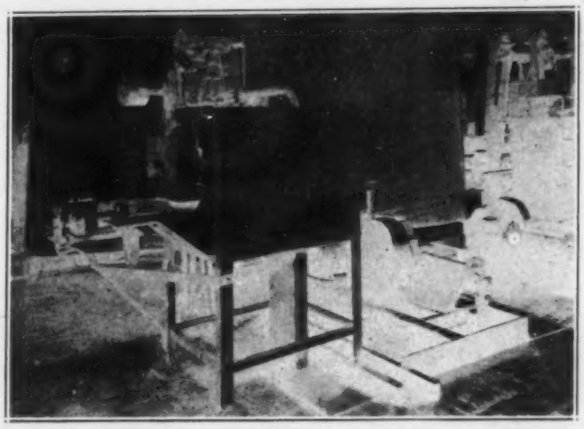


FIG. 9—Pusher Type Electric Furnace, 11 KW.

tungsten-cobalt steel, 1697°F. (925°C.) The average output is 8 pounds of metal per kilowatt hour.

Such inclusions of a heat treatment process along with other manufacturing operations are growing in favor and bring to mind the individual motor drive which had so much to do with the reorganization of industry to achieve the maximum economy of electric power.

For parts that are uniform, a heat treatment process can often be made a routine operation and can be included in the work of the shop producing the parts. The same principle can be utilized for non-uniform parts by somewhat more care in its adaptation. The small shop can profit by the small electric furnace placed where most effective, as well as the larger organization. Furthermore, this principle of unit furnace installation makes possible the use of heat treatment in many cases where otherwise the cost would be prohibitive.

It is unnecessary to recount here the various merits of the electric furnace for heat treatment processes. However, there is one feature which is not as well recognized as its value deserves, hence reference to atmosphere control of furnaces may be worth while. The operation of the standard electric furnace is, in itself, independent of the atmosphere of the heating chamber. This gives almost entire freedom of choice of the furnace atmosphere, either for active participation or for neutrality in the heat treatment process. The only limitation is to avoid gases, such as sulphur, which would attack the alloy of the resistors. Such gases are not often present.

The use of steam as the atmosphere for annealing of copper is a common use of heating chamber atmosphere. The efforts to provide suitable atmosphere and at the same time burn fuel is one of the old problems of the combustion type furnaces. Somewhat crude methods in the way of burning charcoal, sawdust, oil, etc., in the heating chamber of electric furnaces are occasionally practiced.

It is of frequent comment among operators that scaling and decarburizing in the electric furnace is small compared with other furnaces. The limited supply of air in a closed heating chamber of an electric furnace does not provide much oxygen for oxidization. In some cases, such as steel sheets, the CO given off by the metal is an effective atmosphere control.

In many cases it is desirable to provide a definite control of the atmosphere and use it as a part of the heat treatment process. Various gases, such as nitrogen, illuminating gas, air, and others are available and the utilization of these agents in a predetermined way as is possible with the electric furnace offers further opportunities to extend the beneficial effects of heat treatment of metals.

With the advent of steel castings some years ago, there was more or less loss of interest in cast iron. Within the last few years there has been a revival of the study of this useful metal. Iron castings are annealed for the same reason that requires relief of strains in steel castings. This strain relief can be accomplished by ageing. However, this requires time and is uncertain in practice. With heat treatment for this purpose, the time required is a comparatively short period, the investment in castings is reduced, production is accelerated and the results are definite and uniform.

The annealing temperature of cast iron for strain relief only must be kept below the critical range and yet must be high enough to obtain the annealing effect and satisfy production requirements. Our experience shows that the strains in large iron castings can be satisfactorily relieved by holding the temperature at from 932°F. (500°C.) to 1022°F. (550°C.) for from four to ten hours, depending upon the section and weight of the casting.

In annealing cast iron we are concerned not only with an even rate of heating of all parts of the charge but the particular concern is the creation of a definite temperature that will not be exceeded at any point within the inner boundary of the furnace enclosure At the comparatively low temperatures used, the judging of temperature by the eye is well nigh impossible and the pyrometer is essential. However, a large number of pyrometers, as a check on the distribution of temperature, is not very practicable and we have found the best insurance to be the fixed heat distribution of the electric furnace, together with its positive limitation of temperature.

The largest electric furnace, as regards size of heating chamber, in the General Electric Co. plants is that shown in Fig. 10. The inside dimensions are: length 27 1-2 ft., width 16 ft., height 8 1-2 ft. The

connected load is 720 KW. The resistor units are located on the side walls and in the car floor. This furnace is installed in the iron foundry at Schenectady. The average heating and cooling cycle is 48 hours. The power is on for 12 hours, then the charge is allowed to cool in the furnace for 36 hours. The temperature of the charge at the end of the cooling period is around 392°F. (200°C.). The illustration shows a typical casting handled by this furnace. These castings are of large volume and in most cases have many thin webs and partitions. Each casting when delivered to the furnace represents considerable time in production and the expenditure of a large sum of money.

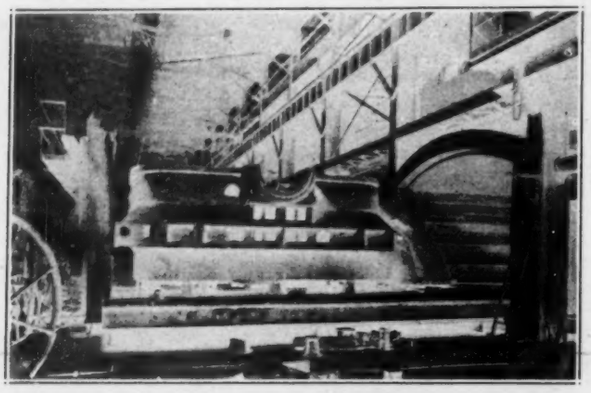


FIG. 10—Car Type Electric Furnace for Annealing Castings. 720 KW. Approximate weight of casting shown 50 tons.

The insurance feature of electric heat is of much value for these large castings.

A number of the electric furnaces in the factories of the General Electric Company, including some of those illustrated, have been in service for a long period of time—as measured by the age of the electric furnace industry—and hence do not represent all that can be done and is being done with more modern electric furnace equipment.

A new electric furnace which succeeds fuel burning furnaces for the heat treatment of steel, such as discs for turbine rotors, shafts, etc., is shown in Fig. 11. This is a car type furnace with a heating chamber 17 ft. long by 6 ft. wide by 2 ft. 5 in. high. The resistors are placed on the roof of the chamber and in the car floor. The connected load is 225 KW. The electrical equipment includes motor drives for the door and for the car. Dual temperature control is provided.

This furnace was installed during the first part of this year and there has not been sufficient time to obtain average operating data. However, the furnace meets, in a very satisfactory way, the service for which it was designed and the organization responsible for results in that particular shop are much pleased with the installation.

Maintenance

The maintenance of all of the standard types of electric furnaces in our factories is a comparatively small item, in general too small to be kept as a separate item in the records. Seldom do we find it necessary to shut down a furnace for repairs. Usually this work can be done between shifts or can wait until it is convenient to spare the furnace from production. For one installation of seven 130 KW elevator type annealing furnaces, which have been in service two years, the engineer in charge estimates that, including a reasonable provision for possible repairs, a maintenance charge of 25 per cent. of that formerly expended for the fuel fired furnaces of that service should be allowed. So far, his repair bill against the electric furnaces has been negligible.

The car type furnace shown in Fig. 3 is installed at Schenectady Works in a forging shop, a trying location for a furnace of any kind due to the vibrations set up by heavy hammers near by. This furnace has been in operation for three years. The average weight of metal annealed per week is 5,000 pounds. A maintenance charge of 70 cents per ton is included in the cost of this heat treatment process. The greater part of this goes for repairs to the car floor.

So far, the Standardization Rules of the American Institute of Electrical Engineers have not been extended to include Industrial Heating. A question that

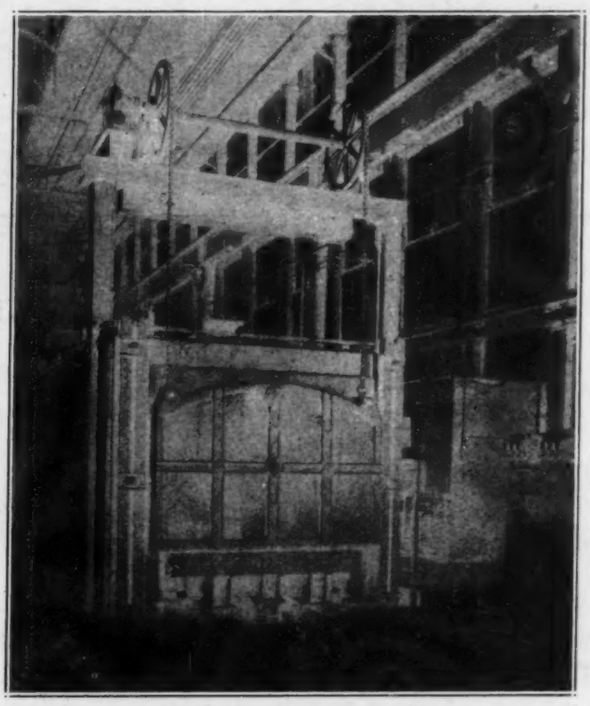


FIG. 11—Car Type Electric Furnace. 225 KW.

is asked frequently is, "What is the efficiency of the electric furnace?" Or the question may be "What is the cost of operation?" There is much confusion in efforts to define furnace efficiency. The electric furnace goes a step farther than a generator, transformer or motor in that it not only effects a conversion of the form of energy supplied to it but, in addition, applies the energy in a process. The efficiency of a furnace, therefore, is measured by its effectiveness in the production of a given product.

This effectiveness is the concern of our plant engineers in furnace application. The pounds per kilowatt hour is not the sole basis for the choice of electric current as a source of heat. The primary consideration in heat treatment processes is quality of product and if a furnace can show a better product the source of heat, whatever it may be, is a minor influence in the selection of a furnace. This is the main reason for the steadily increasing use of electric furnaces in our manufacturing plants.

Ore Unloaders, Blast Furnaces and Skip Hoists

By D. W. BLAKESLEE, E. E.*

THE production of iron from the natural ore is of interest to all engineers. Had not the Cataline forge passed through its stages of evolution to the present blast furnace of a capacity of 800 tons per day, our present industrial life with its engineering aspect would not be possible. Keeping apace with the blast furnace, all the equipment for handling the ore and other materials going to the blast furnace and for handling the iron from the blast furnace has passed through various phases of development. This equipment is of a very specialized nature and of course the modern energy employed is electricity.

Starting with the delivery of the ore at the docks, the ore unloader is the initial apparatus for ore handling. It is the most gigantic and spectacular machine in the iron industry. Ore unloaders are of two distinct types, namely, the bridge type employing a rope suspended grab bucket, and the stiff leg unloader with its rigidly supported bucket. The latter type has certain distinct advantages which make it desirable to use, unless there are other peculiar local conditions which might make it more desirable to use the bridge type unloader. Some of the advantages of the stiff leg unloader are: Absolute control of the mechanism which the operator exercises by having the bucket rigidly supported instead of suspended from ropes; operator located immediately above the bucket where he can see clearly to control accurately the bucket movement; and the unlikelihood of striking the bottom of the hold of the ship severe blows with the bucket, such as often happens with the rope suspended type bucket. Another advantage of the stiff leg unloader is that it is used primarily for unloader purposes and not for transporting any considerable length back from the boat from which it is unloading. This allows the unloader to unload the maximum amount of cargo in a minimum of time.

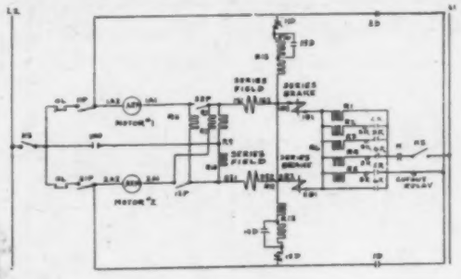


FIG. A.

Bridge Type Unloaders

Bridge type unloaders can be divided into two general classes, namely, the "man trolley" and the "rope operated" types. In the former the traversing motor or motors, also the hoisting motor or motors and drums are mounted on the trolley carriage. A cab, containing the necessary control and the operator, is suspended from the frame work of the carriage. With this arrangement the operator is always near the bucket, and is given an unobstructed view of the bucket, although he is not always as near the bucket as with the stiff leg unloader. In the rope operated bridge, the hoist and trolley motors as well as the hoist and trolley drums are located in a stationary machinery house. Wire ropes leading from the various drums over suitable sheaves to the trolley carriage supply the necessary power for hoisting, lowering and traversing. The operator is located at some fixed point which will afford him the most advantageous view possible for all operations. The control can be located either in the operator's cab or in the machinery house, whichever works out the best all things being considered.

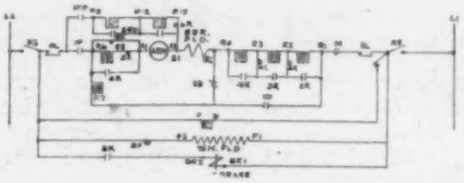


FIG. B.

Bridge type unloaders can be further subdivided according to the number of motions and methods of driving, thus the hoist may be operated by one or two motors, and if by two motors these may be geared together operating as a unit or else separately greared one to the opening and closing drum and the other to the holding drum. The latter arrangement is very common practice on the "man trolley" type. In the case of the single motor hoist or two motors geared together, the holding drum is connected to the motor or motors through a clutch, while the opening and closing drum is positively tied to the motor or motors through gearing.

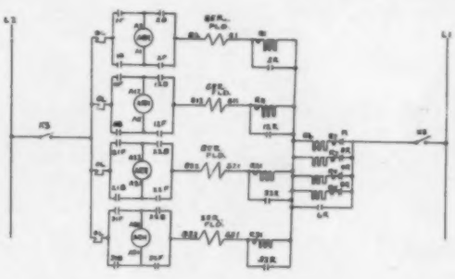


FIG. C.

Fig. A. is a diagram of connections for holding line controller for bucket hoist and Fig. B. one for dynamic lowering.

*Jones & Laughlin Steel Corp., S. S. Works, Pittsburgh, Pa.

In a similar manner the trolley may be driven by one or more motors, but generally a single motor is used for the "rope operated" type, and two motors on the "man trolley" type unloader. When two motors are used on the "man trolley" type one motor is generally geared to each truck.

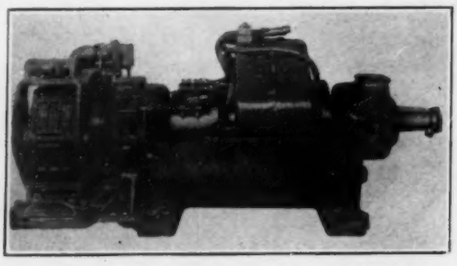


FIG. 1

Fig. C. is a diagram of connections for four moto: trolley controller.

Regardless of the number or arrangement of motors that may be used for the hoist and trolley motions of bridge type unloaders, the service is very severe. In addition to being very severe service, it

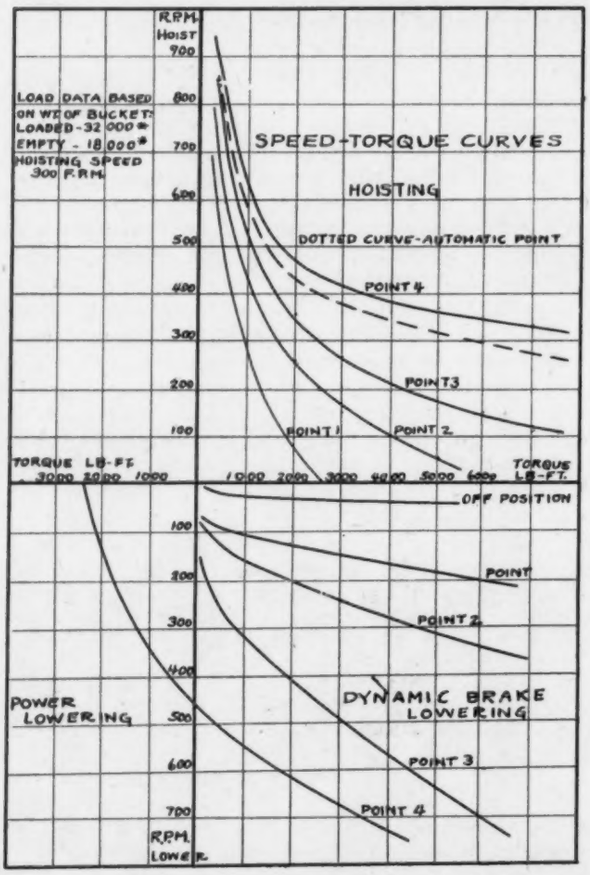
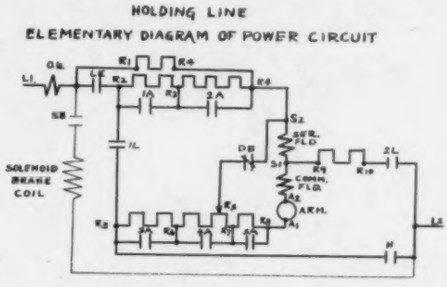


FIG. 2.

must be possible to have very accurate control for spotting purposes, and for that reason direct current motors have been more generally used than alternating current motors. Open mill type series wound motors such as shown in Figure 1 are recommended for hoist and trolley motion. These motors are of extremely rugged construction, have a low armature WR^2, high commutating capacity, and are furnished with non-fibrous, heat resisting insulation, making them exceptionally suitable to withstand the severe shock, to successfully commutate the high current during accelerating and dynamic braking periods, and at the same time withstand the moisture and dust which may be present in the atmosphere where motors are operating.

The motors must be furnished with some form of mechanical brakes to serve as holding brakes. These brakes are either furnished by the bridge builder as a part of the hoisting and trolleying machinery, or by the electrical manufacturer. In the former case these brakes are generally air operated,



CONTACTOR & MASTER SWITCH SEQUENCE TABLE

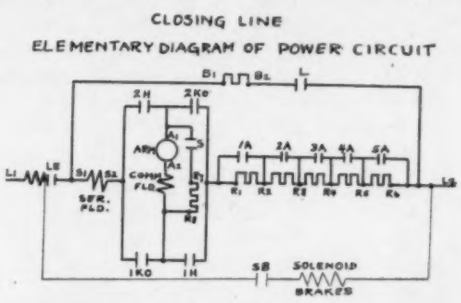
POINTS		LOWER				OFF		HOIST			
		4	3	2	1			1	2	3	4
S	LE	•						•	•	•	•
R	1A		•	•	•	•			•	•	•
O	2A			•	•	•				•	•
T	1L	•	•	•	•	•					
U	3A				•	•					•
C	4A				•	•					•
T	5A				•	•					•
Z	2L	•	•	•	•						
O	H							•	•	•	•
U	DB	← CLOSES WHEN POWER FAILS →									
	SB	•	•	•	•			•	•	•	•

FIG. 3.

while in the latter they should preferably be motor mounted, shunt wound solenoid brakes as shown in Fig. 1. Motor mounted solenoid brakes are preferable because it is much easier to line the brake up with the motor.

The control for the various arrangements suggested above must also withstand severe use and give full protection during normal operation, and include safety features in case of emergency. The hoist control must provide sufficient number of resistance steps to give smooth acceleration, and smooth acceleration and deceleration in the lowering direction. In addition the master switch should be made compact and yet supply a number of hand control points for intermediate speeds. Experience has

indicated that in the past master switches have provided too many hand control points. Some of these hand control points are seldom if ever made use of by the operator. A master with a large number of points is not only more expensive itself but requires more external wiring. It appears, therefore, that a master switch with four points hoisting and four points lowering can be used. In the hoisting direction, standard series connections are provided, giving the well known characteristics shown in the upper right hand quadrant of the curve shown in Figure 2. In the lowering direction, the control must provide for dynamic braking connections, and in addition a kickoff for rapidly accelerating revolving parts on the last point lowering of the master switch. Such connections are secured by means of



CONTACTOR & MASTER SWITCH SEQUENCE TABLE

POINTS		LOWER				OFF		HOIST			
		4	3	2	1			1	2	3	4
	1KO	•									
	1H		•	•	•	•		•	•	•	•
S	2KO	•									
M	2H		•	•	•	•		•	•	•	•
O	LE	•						•	•	•	•
T	1A		•	•	•	•			•	•	•
U	2A			•	•	•				•	•
C	3A				•	•					•
T	4A				•	•					•
Z	5A				•	•					•
O	L		•	•	•	•					
U	S	•									
	SB	•	•	•	•			•	•	•	•

FIG. 4.

the so-called split circuit shown in elementary diagram in Figure 3. A typical set of lowering curves will be found in the lower left hand and right hand quadrants of curves shown in Figure 2.

On account of simplicity of control circuits and ease of adjustment, definite time delay relays are used for acceleration and deceleration. The definite time delay in these relays is not secured by means of dashpots or other mechanical means, but instead is an inherent characteristic of the electrical relays. These relays not only provide automatic acceleration during hoisting and lowering, but also automatic deceleration during lowering. This latter point is an important feature, as it protects the commutator of the motor against excessive peaks during the decelerating period just the same as it is protected against excessive peaks during accelerating period. Emergency dynamic braking is also provided by means of spring closing contactor which closes in case of an overload or in case of power failure. This emergency dynamic braking assists the solenoid brake in bringing the equipment to a quick stop. The dynamic braking circuit is maintained at the "off" position of the master switch as well as all points in the lowering direction.

In the case of the two-motor hoist where one motor is geared to the closing and opening drum and the other motor to the holding drum, each motor is provided with its own control. The holding line control will be as described above, but the closing line control must provide for operating the closing line motor at such speed as will allow lowering an empty bucket with jaws open. This requires that the closing line motor must pay out sufficient line to keep ahead of the holding line motor and prevent the jaws from automatically closing as the bucket descends. The elementary diagram for such holding line control is shown in Figure 4.

The control for the trolley drive must be reversing and provide power in each direction of travel and also some means for stopping. These features can be provided in either plain reversing control suitable for plugging service or by a reversing dynamic braking control. On account of the simplicity and greater reliability as set forth in Mr. J. A. Whitcomb's discussion of Mr. N. L. Mortensen's article on direct current hoist and trolley control for ore bridges in the 1923 Volume, A. I. & S. E. E. the plain reversing control suitable for plugging service is recommended. The dynamic braking type of control requires a master switch with a large number of points that is required on the plain reversing control. Where a master with seven points forward and reverse is used for dynamic braking control a three or four point master can be used for the plain reversing control.

Mechanical brakes, either air operated or electrically operated, should be provided. With dynamic braking type of control these brakes must be arranged to set with the master in the off position, while with plain reversing control these brakes need not set when the master is in its off position. It is necessary to have the brakes set at the off position for master switch in the case of the former because dynamic braking will not bring the trolley to a complete stop. Plugging the motor will stop the trolley and, therefore, does not need to be supplimented by mechanical brakes, in which case the brakes may be used for emergency operation in case of failure of power for example.

Definite time delay accelerating relays of the same general type as described under hoist control are used on trolley control except that in the case of the plugging control the plugging relays instead of being definite time are actually arranged to operate on counter e.m.f. of the motor. The advantage of the counter e.m.f. relays is that when starting the trolley from rest the counter e.m.f. relays are arranged to allow the plugging section of the resistance to be cut out at once, whereas if the time relay were used, a certain definite time would have to

elapse before this could take place. Such delay would be unnecessary and annoying in that production would be held up to the extent of the extra delay in short circuiting the plugging section of resistance. During plugging operation, the plugging section of resistance is not allowed to be short circuited until the motor has been brought to approximate standstill.

Auxiliary motors usually found on bridge type unloaders are apron hoist, bridge propelling, and

FIG. 5.

motor operated rail clamps. The detail for these drives, which ordinarily are standard applications, will not be included in this description.

Stiff Leg Unloaders

Stiff leg unloaders or Hulett unloaders as they are more often called really consist of a massive pantagraph mounted on suitable truck and carrying a bucket on an extension of the forward leg of the pantagraph The rear short vertical leg is always in the vertical position and therefore the outer leg carrying the bucket is also always in a vertical position, but can be hoisted or lowered depending upon the two parallel horizontal members of the pantagraph. The pantagraph is counter-weighted in such

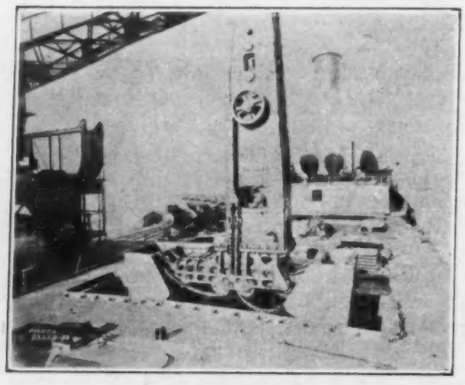


FIG. 6.

a manner that there is just a little tendency for lowering the empty bucket. A fleet of four stiff leg unloaders are at work on location of Figure 5 unloading the ore boat shown in the foreground. An ore bridge may be seen in the background.

Because of the greater possibility of speed control, direct current motors have been exclusively used on stiff leg unloaders. , The principal motions on a modern stiff leg unloader consist of the following:

Main Hoist	Hopper gate
Bucket opening and closing	Larry travel
Leg rotate	Larry hopper
Traversing	Bridge travel.

Of the above motions, the motors on the main hoist, bucket opening and closing, and leg rotate, must be provided with special bearings to permit tilting through an angle of about 70 degrees. The main hoist, bucket opening and closing, traversing, bridge travel, and hopper gate motors are compound wound, the shunt fields of which must be suitable for continuous connection to the line. The balance of the motors are standard series wound machines. Mill type motors are recommended for the various motions, an open motor being used on an air hoist drive and enclosed type on the other motions.

The main hoist motor is provided with a shunt wound brake, preferably of the motor mounted type. The control for the main hoist must provide for hoisting and dynamic braking for lowering, with a power kick-off point on the last point of the controller. The first point in the hoisting direction

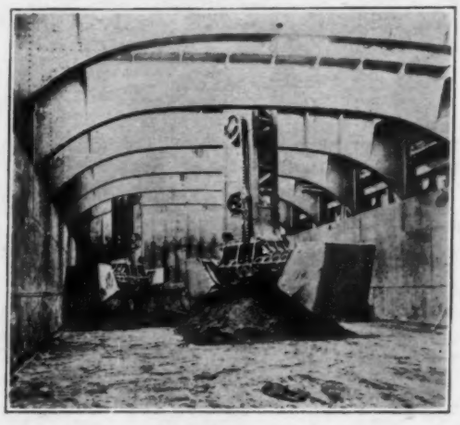


FIG. 7.

must provide a low torque point of about 10 per cent normal motor torque, which is for the purpose of keeping slack out of the line while the bucket is scraping up and down in the ore. Another special feature of the control is the slowdown and stop by means of limit switches at the top of travel. It is necessary to carefully slow down the motor so that it will not stop faster than gravity will stop the beam itself. If the motor should slow down faster than gravity will slow down the beam, there will be slack rope in the hoisting line. Emergency dynamic braking is also provided in case of a failure of power or overload. Four hand control points hoisting and lowering should give a sufficient number for satisfactory operation.

The bucket closing and opening motor will be provided with a shunt wound solenoid brake. The control should provide reversible magnetic control giving power in each direction, but provide at least one step of resistance connected in multiple with the motor armature for slow speed Limit switches are provided for slowing down and stopping the motion in each direction of travel, slow down being secured by means of the resistance which is connected in multiple with the motor armature and the connecting of the resistance in series. Three hand control points are recommended. A stall relay is very often

provided, which will insert resistance and limit the current input of the motor in case the bucket closes on a rock or other non-crushable material.

The leg rotate motor should be provided with a series brake which can be adjusted for light torque. The control should be a plain reversing control with one point forward and reverse. It is desirable to keep this control as simple as possible in order to limit the number of control wires to a minimum. A limit switch is required, which will cut off power at the limit of travel in each direction.

From Figs. 6 and 7, it may be seen how important it is to obtain close control.

The trolley or traversing motor should be provided with a shunt wound brake. The control should be reversing magnetic control with one step of resistance connected in multiple with motor armature on the first point of controller. This point of the controller should be arranged to give just enough power to keep the trolley moving after it has once been started, but should not be enough to start it from rest. The low torque provided by the first point of the controller is very useful in making the trolley motion give a little bit when loading the bucket.

The bridge propelling motor is provided with a series wound solenoid brake. The control will be a simple reversing magnetic control arranged to give power in each direction of operation. A three-point master switch may be used for this service. Occasionally it is desirable to be able to control the bridge motion, not only from the operator's stand in the stiff leg immediately over the bucket, but also from some point on the bridge structure. Such arrangement would call for two master switches and it would be desirable to have interlocking between master switches such that it is necessary to have one master switch in the "off" position before it is possible to operate from the other master switch and vice versa. Sometimes this interlocking feature is dispensed with in order to keep the number of control circuits down to a minimum.

The control of the larry car depends upon the type of track used. If a level track is used, the control must be made for reversing service, but no solenoid brake is required. If, on the other hand, the track has quite a grade which is often the case, a non-reversing control is all that is required and, of course, a suitable brake should be provided. In the level type the control, in addition to being reversing, should provide creeping speed points by means of resistance connected in parallel with motor armature. Slowdown should be obtained by means of limit switches which will insert resistance and at the same time connect the resistance across the motor armature. A final limit switch at each end should also be provided for shutting off power at the end of travel.

The braking on the car will be accomplished by means of the foot brake manipulated by the operator who rides the larry car. In the case of the inclined track the control may be reversing or non-reversing as desired. If the control is reversing, it should be arranged to give power for hauling the larry up the incline and power or dynamic braking for lowering it down the incline and with a solenoid brake which will set with the controller in the "off" position. Non-reversing control can be provided which will furnish power for hoisting the larry up the incline and for travel in the opposite direction. Means should be provided for releasing the brake and allowing the larry to coast down.

The hopper gate motor requires no brake and a plain reversing magnetic control, somewhat similar to that used for the bridge motion, may be used.

The larry gate control is a standard reversing drum control with starting duty resistance and series wound motor-mounted solenoid brake. A suitable protective panel should be provided for giving overload and undervoltage protection to this motor.

In all of the above magnetic control equipments, definite time delay accelerating relays are used. The operation of these relays is similar to that given in connection with the control description for bridge type unloaders. In addition to the individual controls described above for the stiff leg unloader a main line switch and contactor panel should be provided. This panel should mount a main double pole line switch for disconnecting all power from the unloader. The line after passing through the main line switch should divide, one branch passing through a contactor of suitable capacity for supplying the main hoist, the bucket opening and closing motor, the leg rotate, the trolley and bridge propelling motors. The other branch circuit should pass through a second contactor supplying current for the hopper gate, the larry car, and the larry car gate. One overload relay should be located in each of these branch circuits so that in case of overload in one or the other of the branch circuits the corresponding line contactor will drop out. Two emergency control switches should be provided, one in the operator's stand on the stiff leg for controlling one of the branch contactors on the main panel, and the other emergency switch should be located somewhere on the larry car for controlling the other branch line contactor. The opening of these emergency switches will drop out their respective contactors which in turn disconnect all power from their respective parts of the unloader.

BLAST FURNACE PERFORMANCE AND SKIP HOISTS

The blast furnace is the heart of the iron and steel industry and pig iron is its life blood. Upon the successful operation of the blast furnace depends the development of the industry. Blast furnaces are continually being improved both by theoretical design and by experimental changes by operators of the more progressive plants. The trend of development is toward larger furnaces and increased tonnages with due consideration for heat balance, all of which means a more economical production of pig iron and a reduction in the cost of steel.

A few of the broad-minded plant managers, who realize that the advancement of the blast furnace industry as a whole means the advancement of all its component parts, have co-operated by furnishing data from which the following composite figures were derived. These are based upon the operation of nine of the larger blast furnaces. The following do not represent the best results but are averages from plants in various locations using different grades of raw materials entering into the furnace, different designs of furnaces of various ages and different

methods of operation. One of the furnaces operated 365 days in the year reported and another only 72 days: one furnace used 1012 pounds of stone per ton of iron, and another 735; one 20 pounds of cinder and scale, and another 535; one produced 144 pounds of scrap and another 26; one consumed 138 pounds of scrap and another 0; the blast temperature of one was 1161 degrees and another 967, etc. Therefore only average results are indicated.

Average Performance of Nine Large Blast Furnaces:

Tons Produced During One Year	180,443
Days in Operation	295
Average Tons per Day	598
Pounds of Coke per Ton of Iron	1,993
Pounds of Stone per Ton of Iron	923
Pounds of Cinder and Scale per Ton of Iron	254
Pounds of Scrap Produced per Ton of Iron	59
Pounds of Scrap Consumed per Ton of Iron	81
Cu. Ft. of Air per Minute	47,694
Blast Temperature	980
Gas Temperature	386
Blast Pressure	17
Cu. Ft. of Air per Pound of Coke	59
Cu. Ft. of Air per Ton of Iron	121,194
Ave. Grs. of Moisture per Cu. Ft. of Air (4 Fces.)	3.86
Tons on Present Linging	439,634

ANALYSIS

Slag.		Iron.		Gas.	
$Si\ 0_2$	35.99	Si	1.45	$C0_2$	12.95
$A1_20_3$	14.23	S	0.031	C0	25.57
Fe	042	Mn	0.95	H_2	3.49
Mn	0.59	Ph	0.125	N_2	58.14
MgO	2.72				
CaO	44.27				
S	1.41				

Coke.		Stone.	
$Si0_2$	5.17	$Si0_2$	2.14
Vol. Mat	1.24	R_20_3	1.26 (5 fces.)
Fixed C.	88.42	(Fe 0.24—$A1_20_3$ 0.20)	4 fces.
Ph.	0.014	CaO	51.98
Ash	10.35	MgO	1.60
R_20_3	3.28 (5 fces.)	Ph	0.007
(Fe 0.65—$A1_20_3$ 2.56)	4 fces.	S	0.111
S	0.74		

About 20 per cent of the total heat of the blast furnace is lost and unaccounted for. Much research work remains to be done on the blast furnace to prevent the loss of heat. By making the firebrick lining 50 per cent thicker the heat balance may be directly improved; also such a change may indicate other changes to further improve the furnace operation. One of the contributing factors to successful blast furnace operation is modern electrical skip hoists for charging the raw materials.

Skip Hoists

A skip hoist may also be used for elevating coal, cinders and other materials of free flowing nature. The skip hoist is an inclined elevator with a bucket having wheels on one side running on tracks so arranged that when the car reaches the proper place it is automatically dumped. Due to its importance the skip feeding the blast furnace is by far the most outstanding of the different installations and receives the most careful consideration in the selection of the electrical equipment. It is essential that this skip hoist be ready at all times to deliver a load of ore, limestone or coke which requires great reliability in the operation of the electrical end. Also of considerable importance is the distribution of the load being dumped from the skip which requires substantially constant speed of the skip regardless of the material being hoisted. These requirements mean, therefore, that the motor be rugged mechanically and stable electrically; that the control devices be kept to a minimum to avoid complication and yet positive in their operation.

Direct current operated equipments are perhaps the most generally used due to the ready availability of this form of energy and also to the ease of obtaining slow speed operation. Alternating current operated equipments, however, are often used particularly on the slower speed skips since in this case motors having a 3:1 or a 4:1 speed range are used. whereas a higher speed skip would require a large motor frame size to obtain the necessary winding

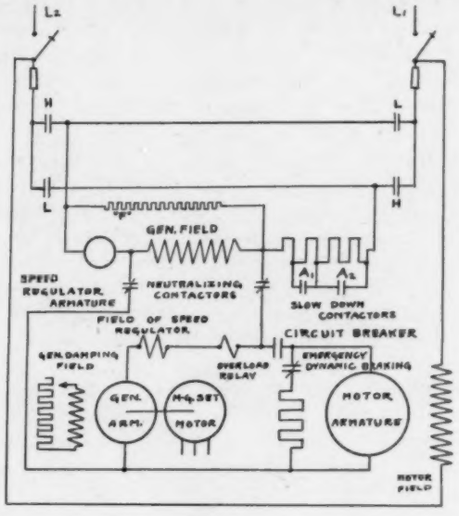


FIG. 8.

space for the number of poles to give an adequate slow speed. In addition to being expensive the motor would have the great disadvantage of excessive flywheel effect and consequently would be difficult to bring to a stop in a short distance. High speed skips, therefore, can be most satisfactorily operated by a direct current motor.

In the case of rheostatic controlled motors slow speed is obtained by armature shunt connections. While a wide range between full speed and slow speed is not obtained a variation in the slow speed operation, due to different loads, of as much as 30 per cent is obtained. While this means an uneven distribution of load this form of operation is very generally used.

Mention may be made of the tendency toward high speed skips and of the speed regulation after the skip turns the knuckle to give an even distribution of the load regardless whether it is coke or ore. To meet this condition the General Electric Company has been quoting the Ward-Leonard system with several distinctive features as follows:

(1) The generator is provided with a "damping winding" by which the rate of acceleration is made an inherent feature, but adjustable without the use of a large number of generator field contactors and relays.

(2) Where the accuracy of stopping must be within approximately an inch, the use of a speed regulator is used which very simply and effectively maintains constant speed regardless of load. Fig. 8 is a simplified diagram showing the connections, and in Fig. 9 is shown curves of the results obtained. AA shows speed regulation of the motor taking into

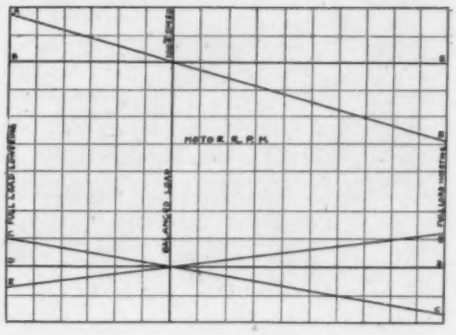


FIG. 9.

consideration combined IR drop in motor and generator armature and also drop in speed of m-g. set without speed regulator. BB shows effect of the compensation by the speed regulator to maintain motor speed constant. CC shows speed regulation of motor without speed regulator when running as slow speed. DD shows motor running as slow speed with regulator and proper adjustment of "F" re-

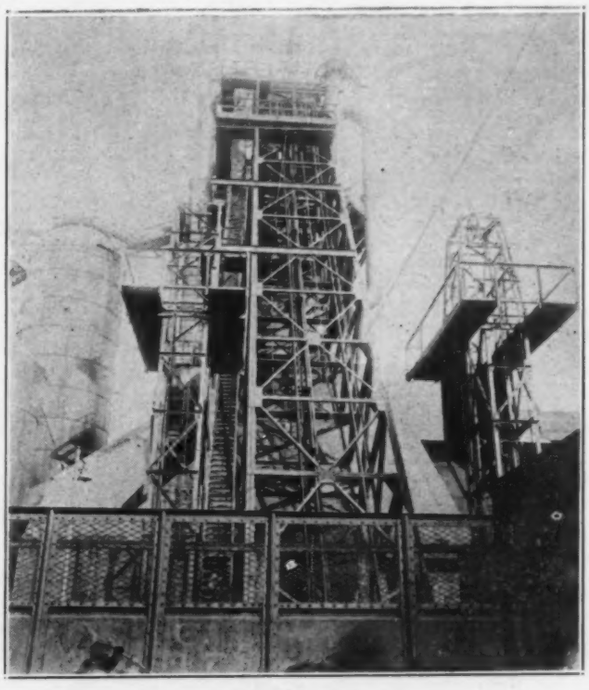


FIG. 10.

sistors to obtain flat regulation. EE shows motor running at low speed with speed regulator and "F" resistor adjusted to increase speed slightly with increase in load so that drift of skip when stopping will be equalized; that is, from a given speed the drift will vary with the load, therefore to bring the skip to a stop at a given point each time regardless of load a slightly higher speed should obtain when hoisting a heavy load than when hoisting a light load.

The control equipment for such a system is very simple and inexpensive since small values of current are normally interrupted and since the devices in addition are few in number, greater reliability is obtained.

Fig. 10 is a picture of a Lidgerwood skip hoist serving a blast furnace at the Weirton Steel Co.; the drum for which is shown in Fig. 11, with its

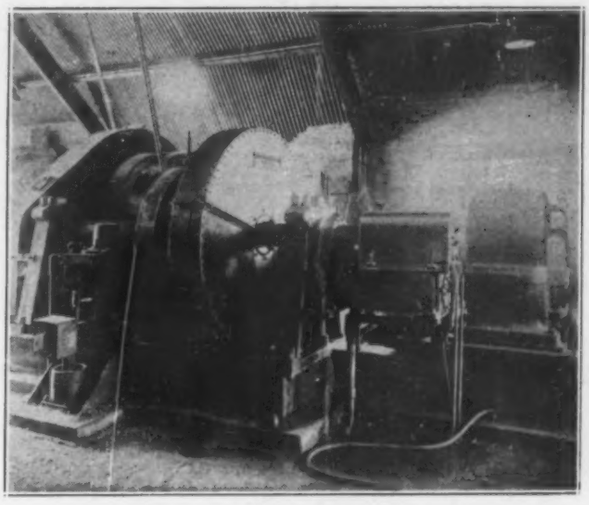


FIG. 11.

driving motor, and Cutler-Hammer travel limiting equipment and band brake.

SKIP HOISTS FOR COAL, COKE AND ASHES

The skip hoist is essentially an elevator and, like the bucket elevator, its use is confined principally to the elevating of bulk materials. Behind the widespread use of the skip hoist is the basic fact it is absolutely a hoist and not a conveyor; as a hoist running on slightly inclined or vertical tracks, it presents the shortest, most direct, and cheapest route for elevating material. Valuable acreage need not be lost due to the necessity of having a long conveyor run. The application of the skip hoist begins where the bucket elevator reaches its limitation. When

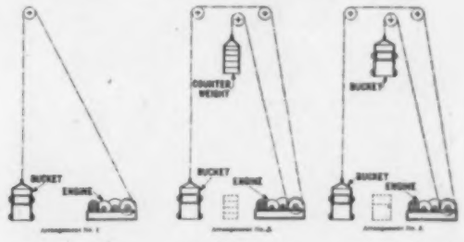


FIG. 12.

materials are non-abrasive, when the capacity is moderate, and when the lift is not high, bucket elevators are quite satisfactory; but when the tonnage is large or the material is abrasive or hot or corrosive, or when the lift is high, the skip hoist should be used. The relative cost of upkeep is very low because the skip hoist is simple in construction and

for that reason rarely ever gets out of order. The material handled comes in contact only with the inside of the large steel bucket where its hot, abrasive, or corrosive properties can cause very little wear.

Fig. 12 shows diagrams of the three general arrangements of skip hoists. Arrgt. A is of single-

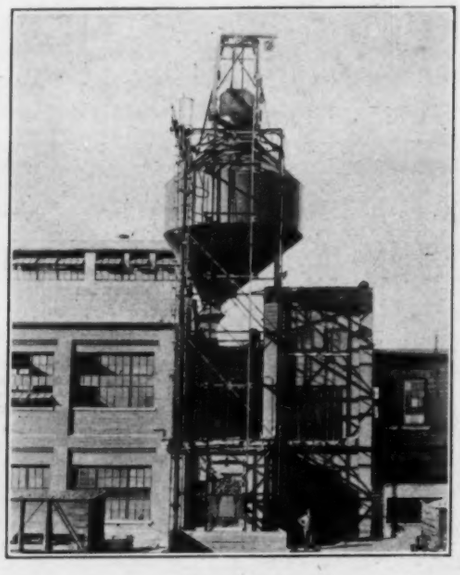


FIG. 13.

bucket, unbalanced skip hoist. It has the advantage of low first cost. It should be used only for smaller and less important skip hoists, where low first cost is an important essential requirement, and uniformity of motor load is not important. See Fig. 13. Arrgt.

FIG. 14.

B, Fig. 12, is of single-bucket, counterweighted skip hoist. In this arrangement the skip bucket is counterweighted by a traveling weight equal to that of the total weight of the skip bucket plus half the weight of the material in the bucket. The unbalanced load on the hoisting engine is only half of the weight of the material in the bucket. There is load on the hoisting engine both when the bucket is raised and when it is lowered. For these reasons the size of the hoisting engine motor is small and the load on the motor is nearly constant. This is

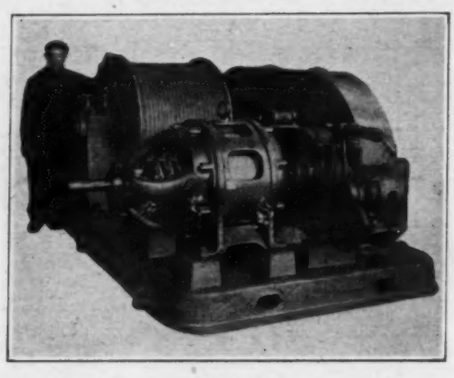


FIG. 15.

the arrangement in most general use. It should have preference over the other two arrangements when the capacity is moderate. Arrgt. C, Fig. 12, instead of having a counterweight has a second bucket instead, the two buckets are in balance, one going up while the other is coming down. This arrangement is most satisfactory for the larger capacities. It takes less energy than the others and requires less head room and less depth for its installation. See Fig. 14.

The motive power of the skip hoist is furnished by the winding machine, or hoisting engine, which operates the bucket by a steel cable. Of course,

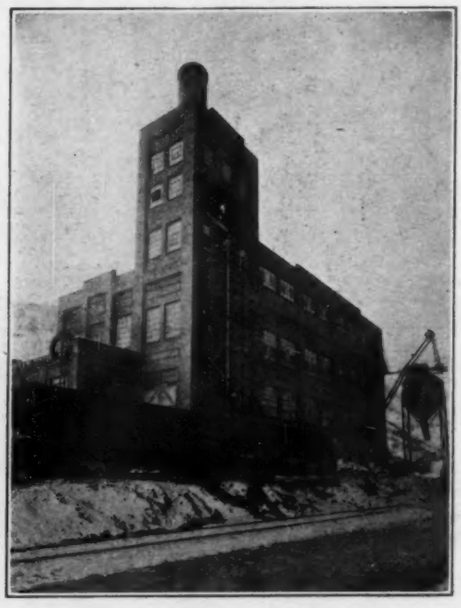


FIG. 16.

energy is supplied to the installation in the form of electricity which permits of close and safe control. The motor may be either alternating or direct current, and with motor or magnetic brake. See Fig. 15. The control may be semi-automatic or fully-auto-

matic; in both, the winding machine motor is controlled by an automatic contactor panel. The only required manual operation in connection with the semi-automatic skip hoist is the pushing of a button or the throwing of a master switch. This is done after the bucket has been filled, and results in the elevation, dumping, and return of the bucket.

FIG. 17.

In Fig. 16 are shown two skip hoists at the Bethlehem Steel Co.'s plant at Johnstown, Pa. That in the foreground is for coal and the one in the background is for ashes. As shown in Fig. 17, the same skip hoist is used for both coal and ashes. In this installation at Ed. Ford Plate Glass Co, coal is dis-

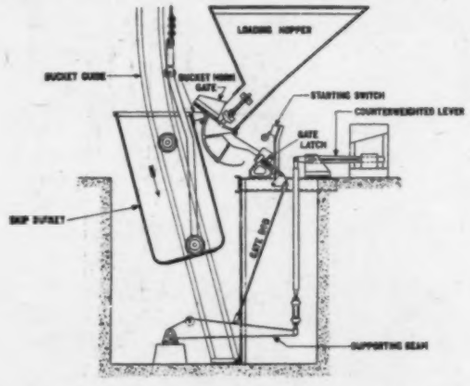


FIG. 18.

charged from the skip at the upper point and ashes at the lower.

With fully-automatic skip hoists, no human assistance is required. They start operating automatically as soon as material is delivered to them, and continue to operate as long as there is material to handle, and automatically stop when there is no longer any material to hoist. The automatic features are patented by various manufacturers. Fig. 18 indicates one design; in this arrangement, as the bucket descends its horns engage the roller lugs on the hopper gate and open it permitting the flow of material. When the bucket comes to rest it is on the supporting beam, which has a rod, which op-

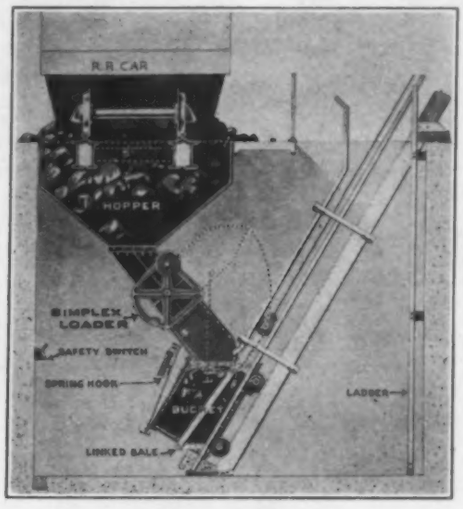


FIG. 19.

erates a latch, which holds the gate open. It has another rod which is attached to the counterweight lever. The weight of the fully loaded bucket just overbalances the counterweight which rises releas-

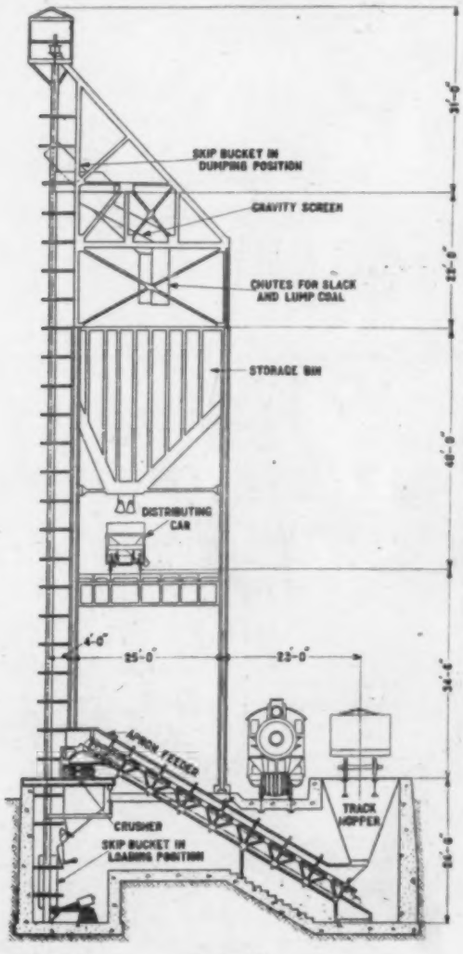


FIG. 20.

ing the gate latch (so that the gate closes by gravity) and the starting switch resumes its normally closed position. The contactor panel then functions: accelerates the bucket to full speed; slows down as it approaches the dumping position; holds the bucket in the dumping position long enough for a clean dis-

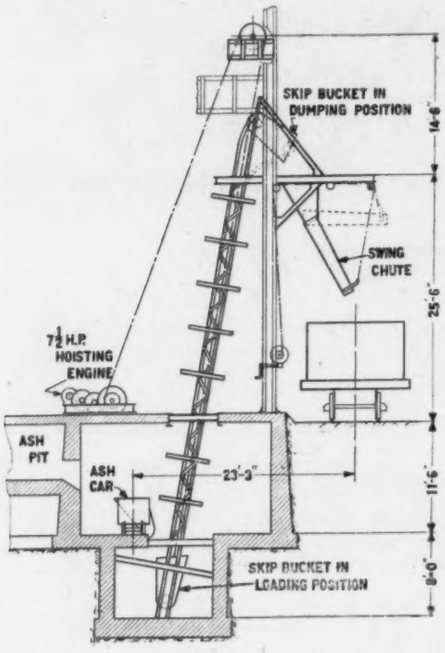


FIG. 21.

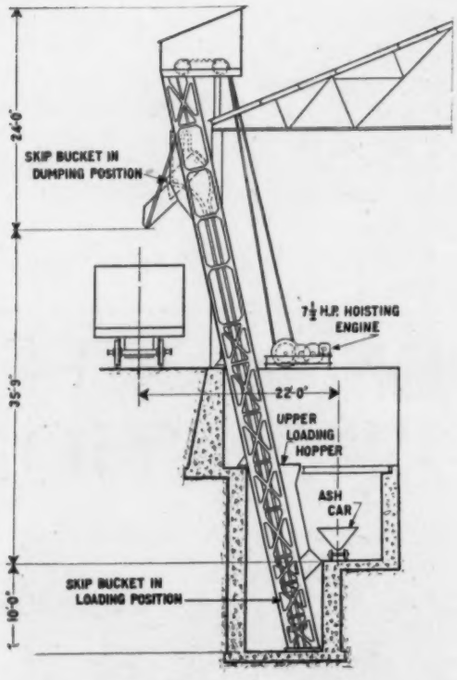


FIG. 22.

charge; then reverses the hoisting engine and returns the bucket to the loading position; the cycle is then automatically repeated.

In Fig. 19 is shown the loading arrangement of another manufacturer. This loader is self damming and opens and closes only by contact with the skip bucket. The bucket in descending engages with a hook on the loader pulling the bucket down and into the open position. As the bucket ascends it closes the loader; counterweights on the loader assist in closing and keeping it closed. Full loads of fuel are

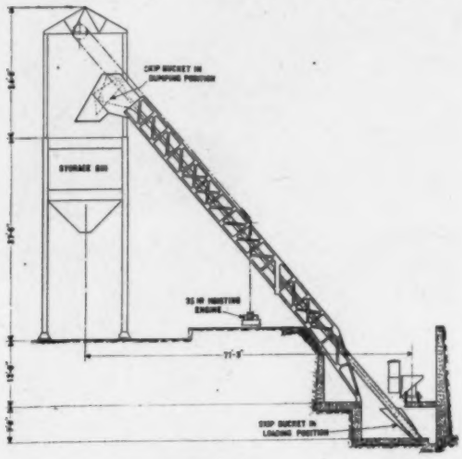


FIG. 23.

passed out at each opening, without flooding or underloading the skip bucket. The only machine used in connection with this skip hoist is the hoisting engine. This machine provides for the direct positive control of the skip hoist at all times without the use of track limit switches.

Fig. 20 is an outline of the double-balanced, fully-automatic skip hoist at the coal crushing and storage

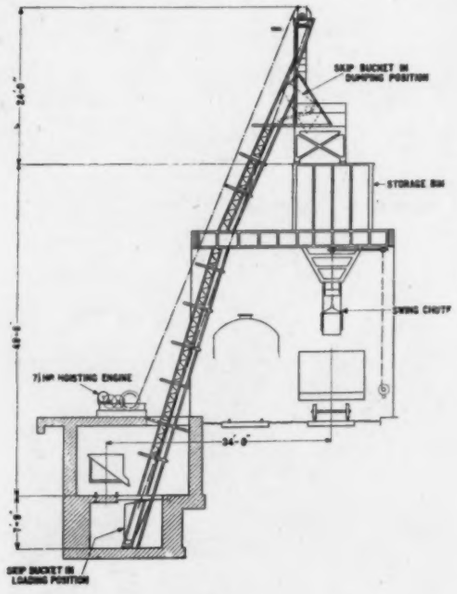


FIG. 24.

plant of the Otis Steel Co., Cleveland, Ohio. Capacity of each bucket: 120 cu. ft. Operating capacity: 150 tons per hour. The same company uses a semi-automatic skip hoist for ashes. This is shown in Fig 21. It has a bucket capacity of 50 cu. ft., which makes a trip in 2 minutes.

Fig. 22 shows the double-balanced, semi-automatic skip hoist which handles ashes for the Mid-

vale Steel Co., Philadelphia, Pa. Capacity of each bucket: 27 cu. ft. Time for bucket to make one trip: 1 minute.

Fig. 23 indicates the general arrangement of the semi-automatic skip hoist for ashes from the Inland Steel Co., Indiana Harbor, Ind. Capacity of skip bucket: 50 cu. ft. Time for bucket to make trip: 2 minutes.

Fig. 24 is the outline of the semi-automatic skip hoist used by the McKinney Steel Co., Cleveland, Ohio, for ash disposal. The capacity of the skip bucket is 70 cu. ft., and the bucket makes a trip in 2 minutes.

Fig. 25 shows the general arrangement of a combination of skip hoists and larry cars for handling coal and ashes in the boiler plant of the Republic

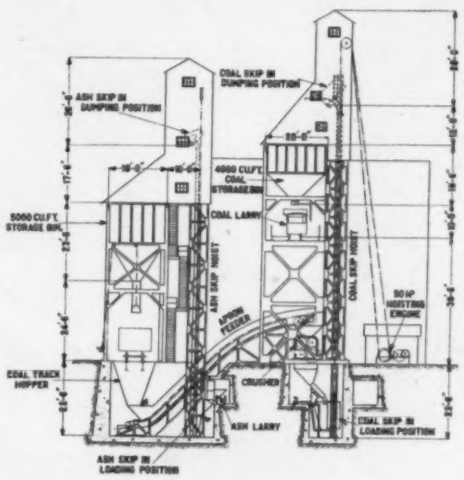


FIG. 25.

Iron & Steel Co., Youngstown, Ohio. The coal drops from the cars into a hopper below the tracks. An apron conveyor feeder carries it to a four-roll crusher. From the crusher it drops into hoppers of fully-automatic skip hoist to be elevated to the overhead storage bin. A larry car, equipped with a scale, takes the coal from the bin and distributes it to the bunkers above the boilers. Ashes are carried from the ash pits in a power driven larry car and dumped into the ash skip hoist bucket, which carries the ashes to an overhead bin. This bin is located above the track on which the coal is brought in.

Skip hoists may employ hatchway limit switches, and traveling cam limit switch; push button control stations, fully enclosed control panel with timing device; slack cable limit switches to operate in the event the hoisting rope stretches or becomes loosened and slips, or in the event of the failure of the lower limit switch. A manufacturer of such hoists for handling ashes, etc., gives the following table of sizes and capacities:

Hoist No.	Hp.	Lift Feet	Cycles Min.	Cycles per Hr.	Capacities—Tons per Hour (Coal 50 Lbs. per Cu. Ft)
14	7.5	20	2	30	10.00
		30	2-1/3	25	8.75
		40	2-2/3	22	7.50
		50	3	20	7.00
		75	3-5/6	15	5.25
25	7.5	20	2	30	18.50
		30	2-1/3	25	16.00
		40	2-2/3	22	13.50
		50	3	20	12.50
		75	3-5/6	15	9.50
40	10	20	2	30	30.00
		30	2-1/3	25	25.00
		40	2-2/3	22	22.00
		50	3	20	20.00
		75	3-5/6	15	15.00
85	15	20	2	30	63.00
		30	2-1/3	25	52.00
		40	2-2/3	22	46.00
		50	3	20	42.00
		75	3-5/6	15	31.00

Coal hoists may be purchased in capacities ranging up to 600 tons per hour.

Checks on the cost of handling coal with a certain skip hoist, in the plant where it is used, resulted in the following:

Energy	$0.0091
Labor	0.0155
Total	$0.0246

In this test 530 tons were loaded; the labor cost was 35 cents per hour, for 23.5 man hours; the cost of energy was 1 cent per kw-hr. In another plant, after handling 60,000 tons of coal with a certain skip hoist the maintenance cost per ton of coal hoisted was zero.

In the purchasing of a skip hoist the following points should be considered:

1. Simplicity.
2. First Cost.
3. Maintenance Cost.
4. Energy Cost.
5. Breakdown Liability.
6. Effect of Hot, Abrasive, or Corrosive Material Hoisted.
7. Space Requirements.
8. Effect of Change of Material Hoisted.
9. Noise Produced.
10. Cost of Labor Required for Operation.

IRON AND STEEL EXPOSITION

Motor Square Garden
Pittsburgh, Pa.

June, 1927

New and Interesting Auxiliary Motor and Control Applications

By PHELAN McSHANE*

TO write a paper having a title like the one assigned to this paper is not to my liking because there is but little that is new in the sense that it is different, but if you would be content to view it in the sense that you would view a new hat, I will be content.

As to being interesting, that will depend on what you are interested in. Things may be interesting because they are unusual, or peculiar, or because of their usefulness, because they perform some function, with less effort or cost.

Each day we hear of some sweeping improvement in first one plant and then another involving millions of dollars. Investigation of these activities will disclose that as a rule the point of interest to those responsible for these expenditures was not increased production but reduced costs and principally, labor cost. So it would seem that we must talk about things that would reduce costs if we are to be interesting.

As an illustration of what can be done with auxiliary control toward reducing cost by the elimination of delays and reduced repair cost, I would like to explain briefly a forty inch blooming mill auxiliary installation. This is a low cost installation; first, because it is possible to maintain their control equipment. I say maintain, I do not mean repair. Fig. 1 shows a front view of the control panels. The controllers are located in one place and in a location that is clean, well lighted and ventilated, which is conducive to the desire to maintain it in its original state. Its construction and accessibility make it possible to effect replacements at any time without interfering with production. The practice of patching up control and motors with the hope of doing a roundhouse job, at the end of the week is a disallusion and snare; for when the week-end comes, there is always as much to do, that much is left undone. This neglect results in rapid deterioration and high repair costs.

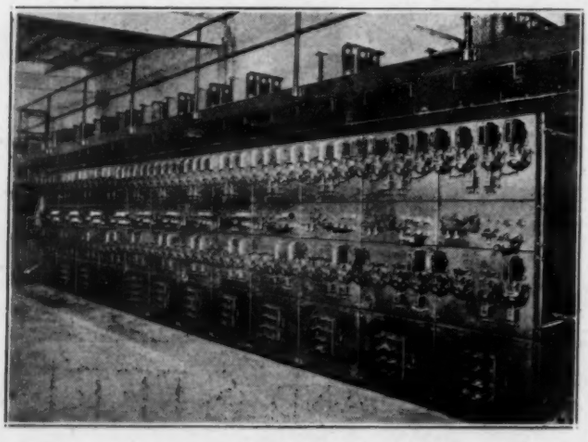


FIG. 1.

You will have noted on Fig. 1 that all the panels are of uniform height. Fig. 2 shows the details of each panel. Directional contactors are located on the top section. The main line and control switches and the protective relays on the next sections, the accelerating and negative line contactors on the next section, and the motor lead transfer switch on the bottom.

Current limit accelerating relays are used throughout. The coils on these relays are series wound, hence have large cross section and are free from the liability of shorting which, by the way, is a possibility when shunt wound accelerating coils are used. As they are located under and operated by the contactors themselves, there is no possibility of the controller operating in improper sequence and therefore on no occasion will the motors have current of improper value impressed upon them during the accelerating period. There are two classes of equipment now in use in connection with the motors, starters, hand controllers. The function of the one is to start the motor but the function of a controller, however, is to start, protect and properly control the motor.

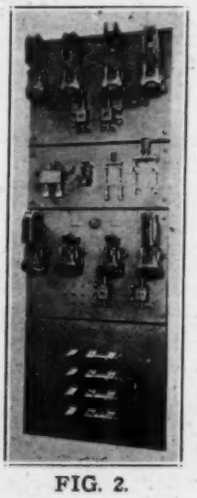


FIG. 2.

It is true that after a period of inactivity, or when the driven apparatus has been tightened up by an overzealous mechanical department man, that the first few starts will be sluggish, but the fact remains that with properly proportioned resistors and properly adjusted relays, no difficulty will be encountered on that score. It is also true that if equipment is tightened up to the extent that starting is overdifficult, trouble will be shortly manifested in overheated motors. There are twelve controllers on the group shown in Figure No. 1; ten regular control-

*General Engineering Division, Westinghouse Elec. & Mfg. Co., East Pittsburgh, Pa.

lers and two spare panels. Three additional controllers have been added since this photograph was taken.

By placing the motor lead transfer switch in the position opposite to that shown, the motor leads are transferred from the regular controller to the spare controller.

The control circuit drum switch is then turned to the left and the control circuits are transferred from the regular controller to the spare controller.

FIG. 3.

FIG. 3A

Thus it is possible to effect the transfer in a few seconds time. To prevent the inadvertent transfer of control circuit to more than one master switch, it is necessary to exchange the operating key of the spare panel to that of the regular panel.

Figs. 3 and 3A show a master switch receptacle and plug. To permit the maintenance of all master switches in a first-class manner the master switch supporting receptacle and plug shown in Fig. 4 was used. In addition to its function as a support for the master switch, this device permits

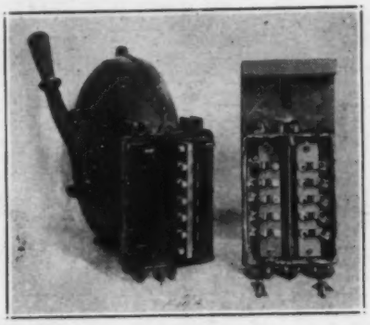


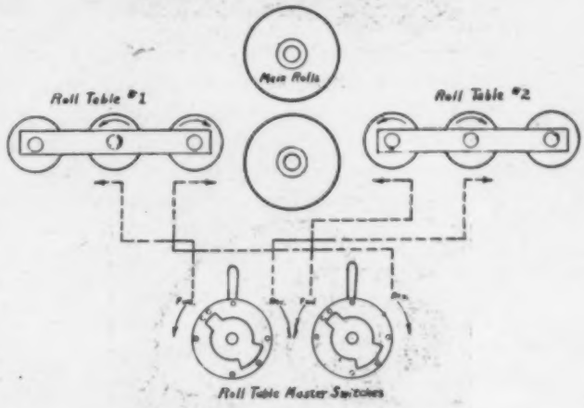
FIG. 4.

the instantaneous removal of a master switch in use and the substitution of another.

Fig. 4 shows the interior construction of the master switch supporting receptacle end plug. It will be noted that a cast partition extends the full length of the receptacle effectively separating the two complete sets of control wires. The lugs on the plug serve a two fold purpose. They act as guides when inserting the plug and also permit the resting of the plug with its master on the floor, without injury to the contacts.

The group of connections on the left are connected to an independent control circuit bus; by the means of this independent bus it is possible to insert a master known as a spare master, and transfer to the spare controller, in case a failure should occur to the regular control lines between the receptacle and the regular controller.

From the foregoing, it will be understood that in a very simple and fool-proof manner a delay



Reversing Roll Table Control Scheme
with
Type "MM" Master Switches

FIG. 5.

caused by the controller, master switch, or control circuits will be of very short duration and that no valid excuse can be offered for failure to maintain the entire control apparatus in one hundred per cent condition. The master switch used throughout is the type "MM" which, by the way, is the original pancake type.

In considering this installation, we viewed the entire mill as a unit and not as a number of units, as is usually the case, with the result that every function of the mill is co-ordinated.

Fig. 5 shows the method of connecting the master switch for the front and back table. The operator is seated; with his feet he operates the

FIG. 6.

master switch for the main rolls; with his right hand, he operates the master controlling and screw down motors. Master switches for the main tables are located to the operator's left. When the table master operating lever nearest him is placed in the forward position the rolls on the front table rotate toward the mill. When the lever is placed in reverse position, the back main table rollers rotate toward the mill. By operating the lever of the next master switch it is possible to operate the other tables.

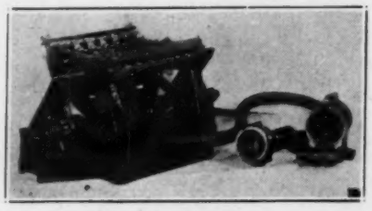


FIG. 6A

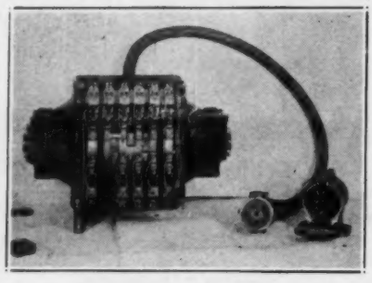


FIG. 6B

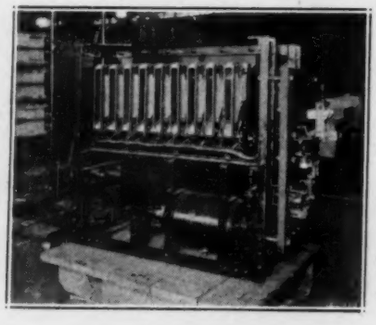


FIG. 7.

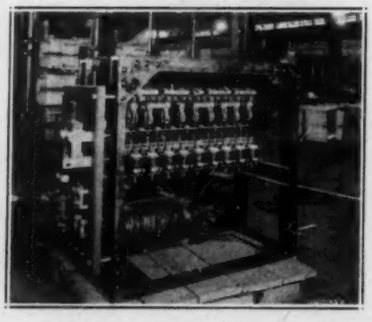


FIG. 8.

All the auxiliary motors in this mill are supplied with cleaned air from the main motor air-washer. The air is admitted at the pinion end of the motor near the bottom and comes out through a special cover over the commutator.

Fig. 6 shows the foot operated master switch that is used to control the main roll drive. This

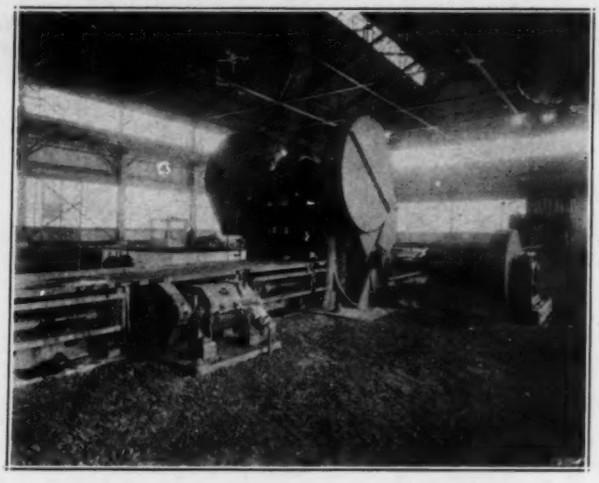


FIG. 9.

is the master switch referred to earlier in the paper. It is operated by tilting the foot forward. The pedals are so interlocked that but one pedal can be tilted at a time. You will note that a train line jumper is provided so that the master may be removed for inspection. A spare controller is available. This controller can be furnished for from 1 to 4 points.

Electromatic Controller

Figs. 7 and 8 illustrate an electro-pneumatic controller that was sold to be used on a soaking pit

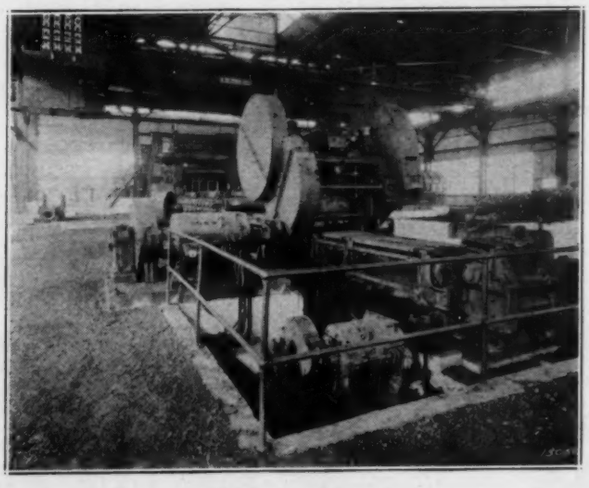


FIG. 10.

crane. On receiving the controller, the customer deciding to cart it from one location to another to give it a thorough test on all kinds of mill applications.

It is now in use on a blooming mill side guard. On this application we have had an opportunity to

simultaneously observe the action of this controller with a magnetic controller in the same service.

The air operated controller was controlling the guard on which the manipulator fingers are mounted and therefore, is the heavier of the two. The air operated controller operated remarkably well.

In my opinion, controllers of this type should prove very attractive for ore bridge applications on

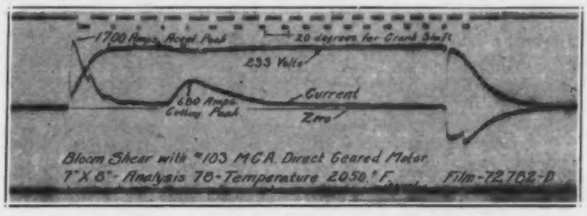


FIG. 11.

account of their compactness and reliability from a safety standpoint, and also the elimination of slate with its attendant liability to breakage for the use of composition panels which has proven unsatisfactory from an insulation standpoint.

Blooming Mill Shear for a 35" Mill

The bloom shear shown in Fig. 9 and Fig. 10 is unusual owing to the fact that the motor is started and stopped each time a cut is made.

The advantage of this construction lays in the elimination of the clutch. We are told that the maintenance of clutches on shears are expensive and where hydraulic actuated clutches are used, it is necessary to take proper precaution to prevent them from freezing in winter time. The bearings on the master gear are also expensive to maintain as they do not lend themselves to proper lubrication which causes the bronze bushing to deteriorate rapidly. To replace a bushing, it is necessary to dismantle the shear which makes the repair costs very high.

It is also true that considerable wear of this bushing is tolerated before it is replaced and the play and back lash on the master gear is very destructive to other parts of the shear. The shear is driven

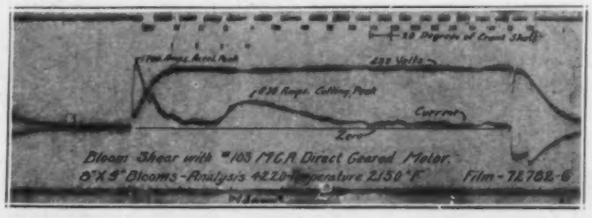


FIG. 12.

by one type MCA frame 103 compound wound motor and is controlled by Westinghouse type C dynamic braking controller and type M M master switch. The master switch is provided with spring and return feature.

The MCA frame No. 103 motor has a one hour rating of 185 HP at 350 RPM and has a one hour torque rating of 2000 lb. ft. and a maximum running torque rating of 6800 lb. ft.

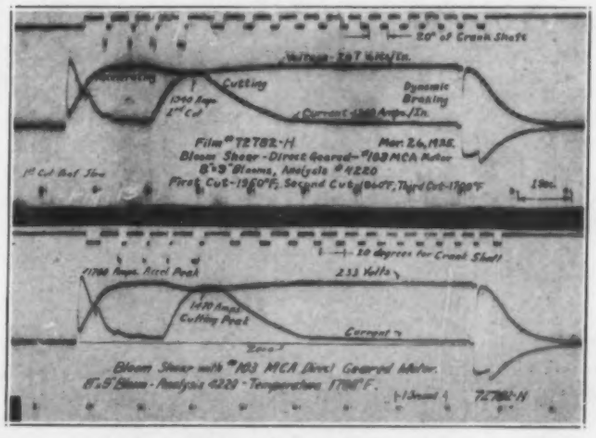
Before closing, I would like to point out three factors that are very frequently overlooked in selecting motors, and I might add control. First, we must apply a motor that will accomplish a given duty cycle in the time required.

Second, we must apply a motor of sufficient heat capacity to continue to perform a given duty cycle as often as is required.

Third, selection of control on the same basis as that of the motor and a control that will permit the motor to be accelerated without subjecting it to excessive peaks before it has had an opportunity to build up its counter electromotive force.

Now to return for the moment to the oscillograph figures:

We have shown that the shear does cut the steel. Let us see if the motor is big enough. We find that the averaged time per cycle varies from 7.36 to 8 seconds. Let us say 10 seconds. We could then make 360 cuts per hour. But 210 cuts is the maximum required. The R.M.S. current value making



FIGS. 13 and 13A

210 cuts would equal 305 amps. The R.M.S. current value of this motor on a one-hour basis is 640 amps. Therefore, we could continue to cut indefinitely at the rate of 210 cuts per hour. The R.M.S. value used includes current generated during dynamic braking period.

Now as to starting peaks. You will note that 1700 amps. is applied at the moment of starting which is equal to a torque rating of 6000 pound feet. This motor has a running torque rating of 6800 lb. ft., which requires 1800 amps. and a maximum starting torque rating of 10000 pound feet, which would admit of an initial starting current of 2600 amps. So it is evident that the motor is not overstressed during either the starting or running period.

The shears are designed to cut 10x10 billets and has an opening between blades of 11½ inches and a total stroke of 12". The gear ratio is 80 to 1.

Fig. 11 is an oscillograph record of speed, voltage, current and time. You will note that the top line shows location of crank pin in twenty degree increments. The next line shows voltage. The third line from the top shows current and the bottom line shows time in seconds. This explanation will apply to the balance of the oscillograph prints.

As state on Fig. 11 the oscillograph was taken when shearing a 7x8 bloom, the temperature of which was 2050 Fr. The analysis was given as 45 carbon. The total horsepower seconds required to make the cut alone was 220. Note the current peak of 680 amps.

On Fig. 12 you will note that the temperature was 100 degrees higher than on the previous billet and the current peak is 50 amps. less, but it is interesting to note that in the first case 220 HP seconds and 2.03 seconds time were required to make the cut while in the second case, 314 HP seconds and 2.20 seconds time was required. This increase in power and time was probably caused by a difference in analysis. The carbon content of the billet cut shown in Fig. 12 was 18 to 25.

Conditions under which Figure 13 was taken were exactly the same as that shown on the previous figure except that the ingot was allowed to cool to 1700 degrees Fr. or 450 degrees less than the previous billet. You will have remembered that the previous slide showed a peak of 660 amps. while here 1470 was required. The other ingot required 314 HP seconds and 2.20 seconds time, while with this ingot 620 HP seconds and 2.62 seconds time was required to make the cut.

Items of Interest

SAFETY AS INTERPRETED BY THE STEEL INDUSTRY

By E. G. JUESREL*

Safety is too big and comprehensive to be purely a shop problem any longer. It is a personal problem now and a duty we owe to ourselves and to the community, wherever we may be.

To those who are in industry, especially those in charge of men, this is a very important thought to be considered, for habits formed on the outside of a plant are bound to reflect in the action of those practising them on the inside and have a direct bearing on industrial safety.

The foreman must realize that he has both new and old employees in his department and each group has its own problems and particular work to do. He must be sure that they understand his attitude toward safety and that he understands theirs. This cooperation is necessary in order to produce good safety results. He must remember that earnest and intelligent supervision not only eliminates waste and increases efficiency but prevents unsafe practices and builds a reliable working group of men which enhances his value as a leader. He has a real opportunity to lead his men to realize that safety is a duty they owe, not only to themselves, but to their department as well.

It is not only a foreman's opportunity to train men to work safely, but it is his responsibility and he should be ever alert to take advantage of any condition that will bring up the standard of his department. It has been said that men will shoot no higher than their aim. He should be sure that they are aiming at 100% safety in his department and keep this thought always before them, holding their interest and encouraging them to help him in putting this over.

Accidents when they occur, while always regretted, should act as a reminder to the foreman and his men that it is necessary to constantly keep everyone awake to his duty of working safely and to realize that accidents are caused—they don't just happen; also that accidents as a rule do not occur the first time a chance is taken, but are the result of continued repetitions of unsafe practices. The foreman should realize that efficient safety supervision will prevent these repetitions. Mistakes made by others often will help him in cautioning his men to avoid a repetition. For while it may be the employee's fault the first time he is injured, it may be indifference or lack of supervision on the part of the foreman that causes the accident to occur the second time. This is the reason that foremen who have been in charge of men are charged with the responsibility of accidents and it is their duty to stop repetitions of unsafe practices.

The chances are that an accident will not occur in the shop. This means that the foreman is forewarned many, many times of a condition which will if allowed to continue, result in personal injury. If he does not take advantage of these warnings he will eventually be brought face to face with a serious condition, and it is for this reason that accidents should be considered very serious. They are in reality failures on the part of the foreman and in a way reflects his general attitude towards his work and the men under him. If he is not alert to the Safety of his men, he in all probability is not alert to other conditions which are considered important. As soon as these thoughts are properly understood by the foremen in industry and put into practice there will be a material reduction in accidents and a more efficient group of workmen developed.

*Safety Engr., Commonwealth Steel Co.

The electrification project now under way on the Great Northern Railway has attracted great attention among railway officials and electrical engineers because of the new system adopted, and the retirement of one of the pioneer electrifications in America, a three-phase system, to give place to the new work. The present undertaking involves the revision of the original electrification between Tye, Washington, at the western end of the Cascade Tunnel and the eastern portal of the same tunnel, and the extension of the electrification westward to Skykomish, Washington. The electrified mileage will thus be increased from four miles to 24 miles of main line trackage, exclusive of yards.

This electrification project constitutes what is reported to be the first step in a program that will include 96 miles of main line via a new tunnel, from Gold Bar to Wenatchee.

By eliminating the duplication of helper service, the delays caused thereby, and other losses of time incident to steam operation such as watering, refueling, standby losses, etc., the electrification is calculated to bring material savings in operating costs. In addition, it will permit faster train movement over the section involved and will virtually fulfill in every respect the requirements of present operating conditions. Consideration has been given to future requirements by an ample allowance for expansion.

In order to secure the advantages of alternating-current transmission and trolley and the direct-current traction motors, the motor-generator type of locomotive was chosen. This will draw power from an 11,000-volt single-phase, 25-cycle trolley. By using this type of locomotive it is possible to take advantage of the inherent merits of both the alternating-current and the direct-current systems. This means high-voltage transmission to the locomotives with minimum copper loss and power loss, static unattended transformer stations along the railway line, light overhead construction, plus the advantages of direct-current traction motors and practically unlimited flexibility of control in operation and regeneration.

The main line of the Great Northern which extends from St. Paul, Minnesota to Washington, has the lowest ruling grade to the Pacific Coast of any of our western railroads. The line is laid with heavy rails and is double-tracked at most of the critical points. The heaviest and most severe grades against load movement are encountered in crossing the Cascade mountains in Washington, where the line is single track. Here the rise to the summit on both sides is very precipitous, and on the west slope a very circuitous route is required to make the ascent. Many snowsheds are required to shelter this section of the line from the deep snow and slides during the winter season.

There are several tunnels along the circuitous route on the western slope, the longest of which is the Cascade tunnel, at the summit. This tunnel, constructed on a 1.7 per cent grade, is about 2.75 miles long. The original electrification which is now undergoing modification, was installed through this tunnel in 1909, mainly for the purpose of eliminating gas and smoke so as to expedite train movement. It extended from Tye at the west portal to Cascade Tunnel Station at the eastern portal, and comprised four miles of main line track and four miles of yard trackage. The 6600-volt, a-c. three-phase, 25-cycle system was used with a double overhead catenary trolley.

When the original installation was made there was no electric power supply within available distance from which power could be obtained. This necessitated the erection of a hydro-electric generating station at Tumwater on the Wenatchee River, a distance of thirty miles from the tunnel. Power produced here by two 2000-kw. three-phase, 25-cycle, 6600-volt units was transmitted to the substation at Cascade Tunnel at 33,000 volts. Water was brought to the plant, which operated under a head of 176 feet, in an 8½-foot flume, two and one-half miles long.

The original electrification itself undoubtedly has served the purpose for which it was installed—the relief from an intolerable condition under steam operation. However, because of its special requirements of organization and operation, the electric service has been tolerated under extremely high operating costs.

Between Seattle and Skykomish, the profile shows that the grades are not unduly heavy, nor are the curvatures excessive, the heavy grades and curves being confined to that section on the west slope of the Cascade mountains, between Skykomish and Cascade tunnel and on the east slope between Cascade tunnel and Leavenworth. With conditions on the east slope the railway is not especially concerned at this time, as certain contemplated changes in line with other reasons, have for the present delayed the electrification of that side. On the west slope, however, a continuous grade of 2.2 per cent is encountered from Skykomish to Tye, a distance of 21.4 miles, with curvatures up to 10 degrees, and from Tye to the summit of the range, through the Cascade tunnel, the grade is 1.7 per cent.

Steam Operation

A 2500-ton time freight, out of Seattle, or rather Inter-bay, the terminal yard, consisting of about 60 cars, covers the 80 miles to Skykomish in approximately 5½ hours when hauled by a 250-ton Mikado type 2-8-2 oil burning locomotive having a normal tractive power of 64,300 lbs. At Skykomish two 2-6+8-0 mallet type locomotives of 260 tons and developing a tractive effort of 78,300 lbs. are cut into the train at about uniform distance apart, to assist on the 2.2 per cent grade to Tye. Including a delay at Skykomish for this operation of one hour and for water at Scenic of 20 minutes, the 21.4 miles to Tye is covered in 4½ hours. On arrival at Tye, the steam helpers are replaced by the electric locomotives, located two ahead and two in the center of the train, and from Tye, the run to Cascade tunnel station is made in 22 minutes. Allowing 15 minutes at Cascade tunnel for cutting out the electrics and inspecting air brakes, the train when reassembled completes the remaining 53 miles to Wenatchee in four hours.

After a thorough review of operation, the Great Northern management, realizing that considerable improvement could be made in the schedule and a substantial reduction in operating expenses, authorized electrification that would accomplish the desired results. This authorization provided for a new system of electrification as past experience dictated that extension of the original system was inadvisable.

The experience, both favorable and unfavorable, gained from the original electrification was very helpful in selecting the new 11,000-volt, 25-cycle, single-phase system.

Some of the reasons for the use of 25 cycles on the new system as compared with the standard commercial frequency of 60 cycles are:

1. Facilitates use of full capacity of 6000-kw., 25-cycle output of Tumwater plant because of liberal design of three-phase machines which

make possible full name-plate capacity at single phase.

2. Some kind of rotating apparatus would have been required to convert single-phase railway load into balanced three-phase load on the power system supplying the energy.
3. 25 cycles is standard for railway transformers and much other equipment which has been developed.
4. Less interference with communication circuits at 25 cycles.
5. Regulation of 25-cycle system is considerably better on fluctuating loads, and losses are less than on 60-cycle system.
6. Copper ground return because of higher impedance of rails would have been required for 60 cycles.

With the limitations contemplated in the power supply for the new electrification, it will be possible always to operate at practically an unlimited number of speeds up to the continuous rating of a locomotive because of the great flexibility of the motor-generator type unit. Furthermore, the method of accelerating a train by means of voltage control of the motor is ideal from the standpoint of economy, both in starting losses and in power demand from the sources of supply and by using a synchronous motor to drive the motor generator set on the locomotive, power-factor correction is obtained, making practically the entire output of the station useful power.

For regenerating braking, the same flexibility of control is available as in motoring. It is possible to regenerate at all speeds within the established range of the locomotive, to practically standstill. The varied train weights over this section and the conformation of the country, make this wide range a very effective feature, as the speed, while regenerating, can be adjusted to suit the grade of any particular section.

The two new Baldwin-Westinghouse electric locomotives for the Great Northern each consist of two cabs which are identical, mechanically and electrically. Each one of these units is self-contained, that is, fully equipped to operate alone. Present plans are to operate two cabs as a road locomotive. Each locomotive weighs about 715,000 pounds, is 94 ft. 4 in. long and has a continuous rating of 88,500 pounds tractive effort 15.5 mph. Maximum allowable speed is 37.5 mph. and maximum rating is almost 7000 hp.

These two-unit locomotives are the most powerful of this type ever built. One of them has been delivered to the Great Northern at Skykomish and the other will be completed this month.

The Great Northern has contracted with the Puget Sound Power & Light Company to supply all power for the electrification. Under the agreement the Tumwater generating plant will be operated by the power company and tied in with its system through a 44-kv. railway transmission line at present and later possibly by its 110-kv. transmission line going via another route over the mountains to Wenatchee.

The present project involved the construction of a 110-kv. three-phase, 60-cycle transmission line from the Beverly substation of the power company, near Everett, Washington to Skykomish; the erection of two new outdoor substations at Scenic and Cascade, respectively, a frequency change set will also be installed in the Skykomish station where connection is made with the 110-kv. transmission line of the power company and the 44-kv. railway transmission line, which is also being erected at this time from Skykomish to Tumwater.

The two 44-kv. railway transmission lines, the trolley construction and signal line will all be carried on single poles along the right-of-way. The trolley contact line is No. 4/0 cadmium bronze supported by inclined catenary type of construction.

Careful consideration has been given to possible interference to signal and communication lines due to the single-phase system. The d-c. signal system will be changed to a-c. 60-cycles with 6600-volt transmission. Telegraph and telephone lines enroute will undergo general revamping, using necessary cables or removing them from the right- of-way entirely Local telephone lines heretofore adjacent to the right-of-way will be removed to a convenient distance therefrom to avoid inductive troubles. Distance as the most effective remedy has been the general basis on which the problem of inductive interference has been considered.

Metering presented some interesting problems to the power company owing to the condition of the contract which calls for the simultaneous measurement of demand at two widely seperated points. In addition, it is necessary to take into account power fed back into the power company's system by the Tumwater plant and by the electric locomotives when regenerating. Power will be measured by two three-phase ratchet meters at each point and demands will be measured by graphic meters to obtain simultaneous records at the two points.

According to the contract billing for power will be made on the basis of the average of the three highest five-minute demands during the month. In the event of power failure any peaks occurring during the first fifteen minutes after service is restored are to be ignored. As all power taken by the railway company from the 110-kv. line of the power company will first pass through the frequency changers, driven by synchronous motors, it will be possible to maintain unity power factor or even a leading power factor if desired.

Simultaneously, with the rehabilitation and extension of the original electric section, a new tunnel through the Cascade Mountains was begun, and when completed this will be the longest railway tunnel in America—seven and three-quarter miles. The present line crosses the divide at an elevation of 3385 feet above sea level. It has sharp grades and curves, numerous snow sheds and several tunnels one of which is the Cascade, 13,873 feet long. On account of heavy snow fall, which reaches a maximum of 410 inches at one point and 670 inches at the Cascade Tunnel each season, it is difficult and expensive to keep the line open for operation. Increasing importance of a thoroughly dependable line, the necessity for additional snow sheds on the present route and the heavy repairs on the existing snow sheds brought expenditures to a point where

a new line on a lower level would show a substantial gain.

The new tunnel line will shorten the right-of-way more than 7½ miles, eliminate nearly six complete circles of curvature and will escape most of the severe snow trouble. The grade will be the same as the present tunnel, but the elevation will be 500 feet lower. Electric power is being used throughout in its construction which it is expected will be completed in about two years.

The Baker-Raulang Co. of Cleveland, Ohio, have recently adapted the Baker Hy-Lift truck for carrying large crates or similar packages. The carriage is fitted with two forks in place of the usual platform and clamps are provided for securely holding either one or two packages. This machine was developed for a large manufacturer of electric ice cream cabinets for soda fountain use. These cabinets are packed in crates of uniform size and 3x3 cleats are nailed to the bottom, thus raising the crate off the floor so that it may be picked up with the forks.

The clamping action is entirely automatic and takes effect as soon as the truck commences to lift. One crate may be picked up and placed on top of another and then both of them carried on one load. In this case the lower clamp drops back out of the way and the upper clamp comes into operation.

Rapid progress has been made in the erection of the five story, arc-welded, steel building at Sharon, Pa., by the Westinghouse Electric and Manufacturing Company. A load test demonstrating the principles involved in the erection of this type of building has been arranged by the engineers of the Westinghouse Company. This load test took place Wednesday and Thursday, December 15 and 16, and was open to inspection to all architects, engineers and other interested parties on these two days.

A portion of the third floor of the building sufficiently large to obtain some complete observations, will be loaded to twice the maximum load for which the floor is designed. It is estimated that 840,000 pounds distributed over an area of 1400 square feet will be required for this test.

The Electric Controller & Manufacturing Company of Cleveland, Ohio, announce the appointment of Farr Electric Service, Inc., 228 W. South Temple, Salt Lake City, Utah, as their representatives.

Larger and more spacious quarters for the Detroit branch of the Graybar Electric Company were opened November 15th according to an announcement from the New York executive offices of the company. The new Detroit distributing branch, consisting of a three story fireproof concrete structure designed to Graybar plans, will be located at 55 West Canfield Street. There will be available in the new building 35,000 square feet of space compared with 21,000 square feet in the present quarters.

The move according to A. R. Maynard, manager of the Detroit house is in conformity with the general policy of his company in establishing larger distributing branches in those cities where distributing needs justify expansion.

In order to eliminate the possibility of mixing gases, and for the purpose of minimizing damage from accidents, the Magnolia Gas Products Company, Houston, Texas, has installed a particularly complete control switchboard with the necessary governing devices. This company manufactures hydrogen and oxygen by the electrolytic process, using a booster type rotary converter and motor generators.

Originally the various control panels were scattered in isolated positions around the plant floor. These are now all combined in a long switchboard on a balcony over the rotary converter and motor generator equipment, a total of 20 panels being used. General Electric equipment is used throughout.

In order to prevent any mixing of the two gases through reversal of the current a reverse power relay is used which shuts down the equipment when the current changes its direction of flow. As a further provision in case of accidents, an emergency push button is used. Depression of this button first opens the air circuit breakers and afterwards the main incoming-line oil circuit breakers. The push button actuates an instantaneous undervoltage relay equipment to accomplish this result.

One relay is arranged to de-energize the undervoltage release on the air circuit breaker and thus open the breaker, when the relay coil is de-energized. When this de-energizing occurs, a second set of contacts is closed, de-energizing an instantaneous relay located on the main incoming-line panel. This, in turn, opens the circuit of the low-voltage release on the incoming-line panel. Thus, when the push button is depressed the voltage relays on the direct-current panels drop and open the air circuit breakers. The rotary panel voltage relays then energize the alternating current panel voltage relay and open the main breaker.

By this method, any possibility of overspeeding the machine, reversing polarity, etc., is avoided because all the direct-current air circuit breakers will open before the alternating-current oil circuit breakers. When leaving the plant, the operators merely have to push the button and the plant will shut down until their return.

Another interesting feature of this installation is the fact that all power for machines, lights, etc., is metered on the watt-hour meters on the incoming line panels. An emergency throwover equipment, located behind the switchboard, is so arranged that the two small lighting transformers are connected ahead of the main incoming-line oil circuit breakers. Thus, in case of emergency when the main incoming-line oil circuit breaker is open, the throwover equipment will throw a few of the pilot lights on the emergency stand-by transformers, thus giving sufficient light to make any inspections necessary.

A powerful 100-ton oil-electric locomotive, the first installed on any railroad in the Northwest, is now at work at the Minneapolis terminal of the Great Northern Railway. It was built by the Ingersoll-Rand, American Locomotive and General Electric companies, and is doing yard and switching work.

Before going into active service, last week, the locomotive was placed on public inspection for one day at the Union Depot, St. Paul and another day at the Great Northern station at Minneapolis. Eight thousand people climbed aboard it and inspected its mechanical features.

Prominent in the crowds, aside from railroad men, were members of leading civic organizations of the Twin Cities, members of engineering societies and hundreds of students of mechanical and engineering classes of the University of Minnesota, at Minneapolis, and of colleges, technical schools and vocational schools in the two cities.

In a folder distributed at the locomotive, the Great Northern asserted that the "advent of this latest type of motive power marks a new era in railway operation and equipment in the Northwest".

Ten railroad systems throughout the country are now using oil-electrics built by the three producing companies.

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James B. Taylor, Master Mechanic, Federal Steel Foundry Company, Chester, Pa.

Carl R. Hogle, Furnace Foreman Power House, Tennessee Coal Iron & Railroad Company, Birmingham, Alabama.

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P. F. Haberstick, Safety Director, Wheeling Steel Corporation, Wheeling, W. Va.

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William T. Fellows, Chief Electrician, The Waddell Steel Co., Niles, Ohio.

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H. P. Ochsenhirt, Construction, Elec. Foreman, Crucible Steel Co. of America, Park Works, Pittsburgh, Pa.

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Harry A. Sterling, Chief Elect., Wheeling Corrugating Co., Martins Ferry Factory, Martins Ferry, Ohio.

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H. Lewellyn, Vice President, Electric Welder Controller Co., Pittsburgh, Pa.

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STATEMENT OF OWNERSHIP, MANAGEMENT, ETC., OF

IRON AND STEEL ENGINEER

(Required by Act of Congress of August 24, 1912)

Name of Publication: Iron and Steel Engineer, published monthly at Pittsburgh, Pa. (Report of October 1, 1926)

Editor—John F. Kelly, Empire Bldg., Pittsburgh, Pa.

Business Manager—John F. Kelly, Empire Bldg., Pittsburgh, Pa.

Names and addresses of stockholders holding 1 per cent or more of total amount of stock: None.

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S. S. Wales, First Vice President, Carnegie Steel Co., Pittsburgh, Pa.
A. J. Standing, Second Vice Pres., Bethlehem Steel Co., Bethlehem, Pa.
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R. S. Sawdey, Director, Van Dorn Iron Works, Cleveland, O.

Known bondholders, mortgages and other security holders owning or holding 1 per cent or more of total amount of bonds, mortgages or other securities: None.

JOHN F. KELLY, Editor and Business Mgr.

Sworn to and subscribed before me this 4th day of October, 1926.

JOHN G. HOSICK, Notary Public.

(My commission expires March 7, 1929.)

Chromalox Electric Heaters

FOR HEATING HARD-TO-HEAT PLACES IN STEEL MILLS

crane cabs	power houses	scale rooms
elevators	pump houses	storage rooms
laboratories	warehouses	wash rooms
service garages	valve houses	welfare buildings
sub-stations	watchman houses	shops and offices

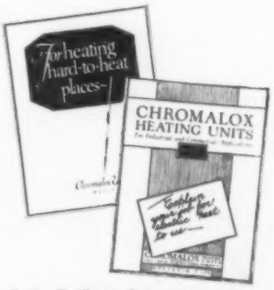
45 Sizes and Ratings. Three types. Horizontal, Vertical, Portable. 1000, 1500, 2000, 3000 watts. 110, 220, 250 volts.

Completely Assembled with 3 feet of cable, and 3-heat switch on standard conduit box. No assembly work!

Easily Installed! Simply mount on wall and connect to power line. Light and sturdy. Easily taken to the next job. Quicker than extending steam line!

Built to Last! The same type electric heaters fully approved for railway and street car service—will operate indefinitely on your heating jobs.

When writing for Bulletin C-108, send details about general construction of building, size of room or space to be heated, number of doors and windows, temperature required and voltage available. Then we can definitely tell you which size and type of electric heaters should be installed.



Left—Bulletin C-108 gives complete details about Chromalox Electric Heaters.

Right—Bulletin C-106—new edition—tells about standard Chromalox Strip, Space, Ring and Immersion Units.

Quick shipments from stock on electric heaters and heating units listed in both of these bulletins!

CHROMALOX

Mail with Your Letterhead!

[ ] Send Bulletin C-106 about Chromalox Units.
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We Need Electric Heat for—

Position I S-12

Signed

CHROMALOX HEATING UNITS

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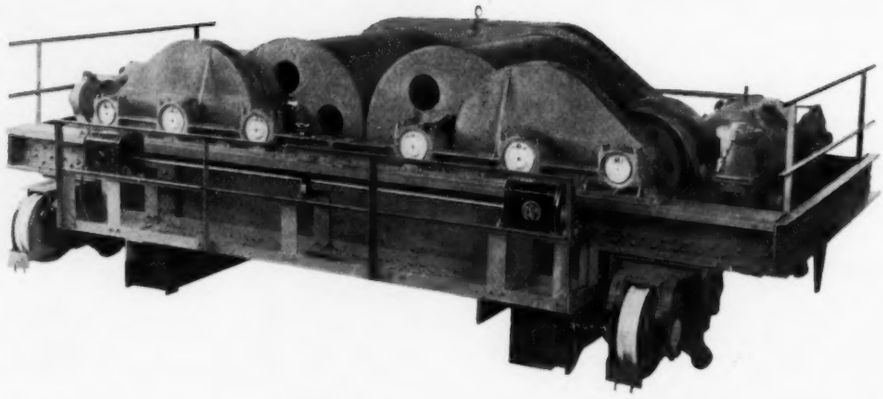
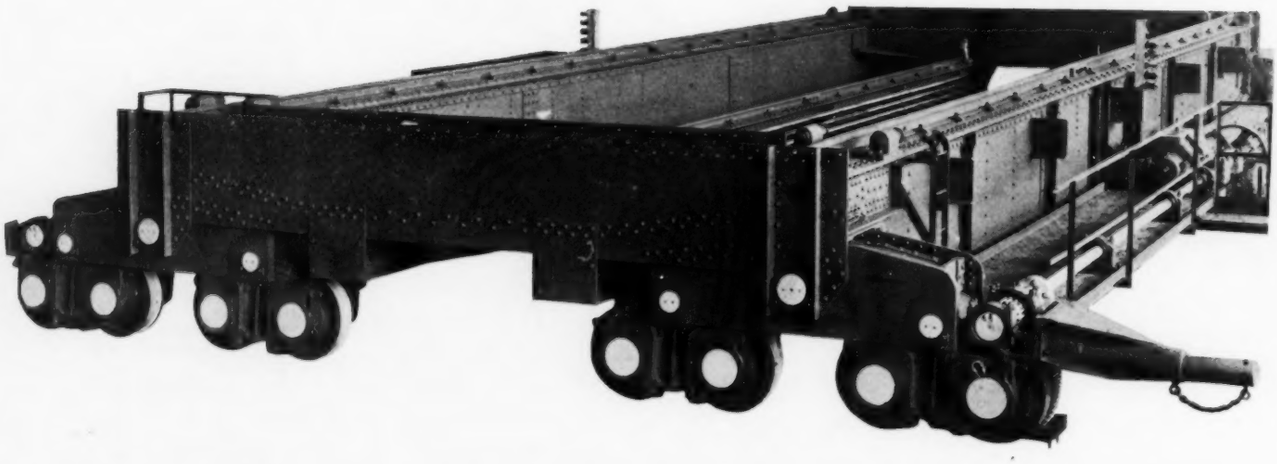
The Railway Utility Company of Chicago is the sole distributor of Chromalox Strip Heaters for use in heating railroad and street cars in the United States and Canada

MORGAN





A 150-TON 4-GIRDER TYPE LADLE CRANE BUILT BY MORGAN EQUIPPED WITH HYATT ROLLER BEARINGS

We have recently furnished more than forty (40) Mill Type Cranes equipped with roller bearings.

In equipping and installing these cranes we have gained valuable experience to assist us in solving your problems.

Our Engineering Department is anxious to assist buyers in the plan and design of equipment especially adapted to their requirements.

"If Morgan builds it—it's built right."

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Electric Traveling Cranes, Rolling Mill Machinery, Forging Plant Equipment, Rock Crushers, Special Machinery for any purpose, Locomotive Repairing and Rebuilding, Locomotive Forgings, Fabricated Structural Steel.

This Silver Strand (Reg.) now marks the shunts of all National Pyramid Brushes

ON ANY brush-equipped electrical machine, look at the brush shunts. Look for the Silver Strand. It is the visible identifying mark on all National Pyramid Brushes—your guarantee of satisfactory brush performance.

All shunts of National Pyramid Brushes now bear this Silver Strand as an identifying mark, visible to the most casual glance. The familiar letters NCC, the three pyramids and the grade number will still be found on the brush itself for your guidance in purchasing and installing. When the brush is in service, the Silver Strand in the shunt is a visual sign to all that here is a National Pyramid Brush, supremely suited for the work for which it is designed.

Thousands of brushes are now in use bearing this shunt, which has the same conductivity as the former unmarked shunts. The Silver Strand is a mark that indicates, but does not affect, the perfection of performance you have learned to expect from National Pyramid Brushes. Look for the Silver Strand.

National Pyramid Brushes

Manufactured and guaranteed by

NATIONAL CARBON COMPANY, INC.

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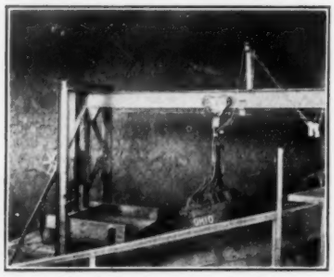
NEW YORK, N. Y. 357 West 36th St. *Phone:* Lackawanna 8153

BIRMINGHAM, ALA. 1824 Ninth Ave., N. *Phone:* Main 4016

36″ Ohio Magnet working on an Insley Crawler Crane driven by gas engine.

OHIO reliable MAGNETS

65″ Ohio Magnets loading scrap into Steamer Lagonda, which carries two 25-ton motor-driven B.-H. Cranes.



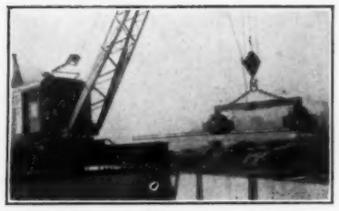
45″ Ohio Magnet separating tramp iron from silver ore at Fresnilla, Mexico.

The Ohio has all mechanical joints gasketed to exclude moisture and retain the compound even if used for continuous magnetic separation work or to handle red hot iron or steel.

Terminals are so well protected that metal dust or moisture does not cause grounds or short circuits.

Each bolt has a soft lead gasket to exclude moisture and is positively locked.

Ohio outer rings do not loosen and seldom break in service.



Two Ohio rail magnets unloading rails from Lake Steamer at Duluth.

55″ Ohio Magnet at work in stock yard of Boynton Furnace Co. on a Shepard Crane.

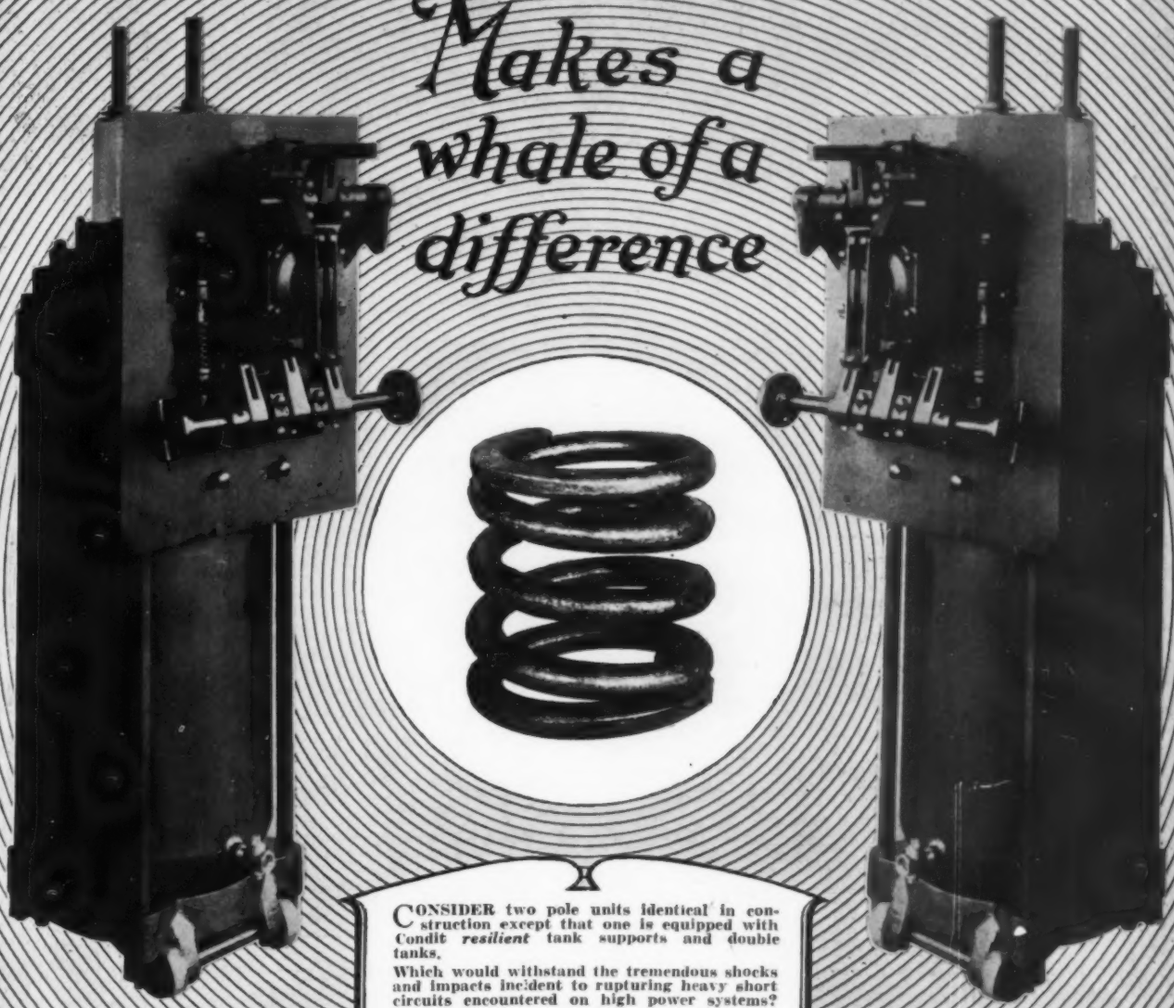
55″ Ohio Magnet working in scrap yard of the David Joseph Co. at Youngstown.

OHIO reliable MAGNETS

The
Ohio Electric & Controller Co.
5903 Maurice Ave.
Cleveland, Ohio

RESILIENCY

Makes a whale of a difference



CONSIDER two pole units identical in construction except that one is equipped with Condit *resilient* tank supports and double tanks.

Which would withstand the tremendous shocks and impacts incident to rupturing heavy short circuits encountered on high power systems?

RESILIENCY, the property which determines the capacity of a material to resist shock, was first applied to oil circuit breakers by Condit. Resiliently equipped Condit Breakers are available in the types and sizes to meet your requirements.

CONDIT ELECTRICAL MFG. CORP.
Manufacturers of Electrical Protective Devices
Boston, Mass.

Get in touch with Condit

Type F-9

Specifications: *Platen or truck type. Standard capacities, 15,000 or 25,000 volts: interrupting capacity 30,000 amperes at 15,000 volts.*

9073

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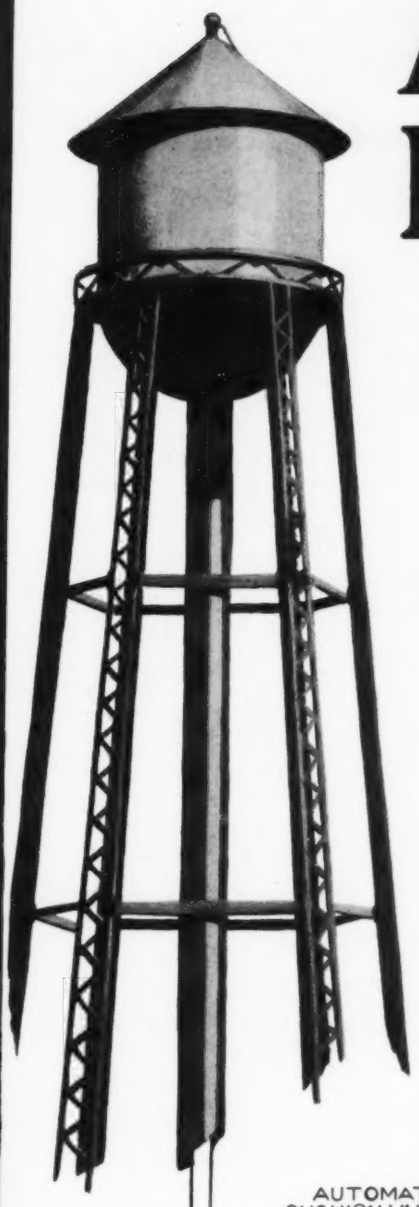
WE are always endeavoring to build the best, 24-hour service, steel mill crane that can possibly be designed.

The Cleveland Crane & Engineering Co.
Wickliffe, Ohio

CLEVELAND CRANES



AUTOMATIC PUMPING

Pumps that operate automatically day after day, without an attendant on the job, are a real economy; no station attendants, no expensive boilers and standby equipment, no dependence upon the human element.

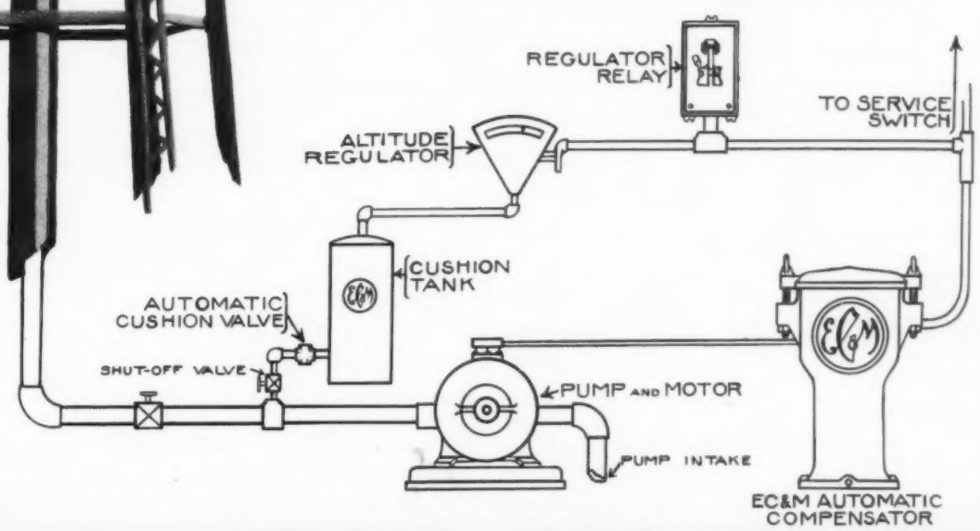
Electrically driven pumps can be started and stopped automatically as the water level in the storage tank varies and you will always be assured of a ready water supply. EC&M Automatic Pump Control Equipment is your guarantee.

Your pumping stations can be controlled by EC&M Float Switches or Altitude Gauges through EC&M Oil-immersed Automatic Compensators or Across-the-line Starters for A.C. motors and through EC&M Direct Current Starters for D.C. motors.

An EC&M Altitude Regulator will maintain the water level in a storage tank fifty feet high within limits of one foot. This is done automatically through the electrical contacts in the Regulator which are a part of the circuit that controls the starting and stopping of the pump motor.

The EC&M Cushion Tank and Valve installation, as shown in the diagram below, is designed to prevent those pulsations of the Regulator needle which result from the surging of the water in the pump discharge line. Spasmodic starting and stopping of the pump motor will not occur where this cushion tank is provided.

Send for Specification Sheets S-21 and S-25 and Bulletins 1016-B, 1020-A, 1033-B and 1042-F.



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National Tube Company	Lorain, Ohio	All Stoves
National Tube Company	Lorain, Ohio	6 1300 H.P. Boilers
National Tube Company	McKeesport, Pa.	7 Stoves
National Tube Company	Wheeling, W. Va.	12 Boilers—250 H.P.
Wheeling Steel Corp.	Steubenville, Ohio	1st order—4 Boilers
Wheeling Steel Corp.	Steubenville, Ohio	2nd order—7 Boilers
Wheeling Steel Corp.	Steubenville, Ohio	3rd order—1 Boiler
Wheeling Steel Corp.	Steubenville, Ohio	3rd order—8 Stoves
Bethlehem Steel Company	Sparrows Point, Md.	1st order—2 Boilers
Bethlehem Steel Company	Lackawanna, N. Y.	2nd order—2 Boilers
Bethlehem Steel Company	Lackawanna, N. Y.	3rd order—8 Boilers
Bethlehem Steel Company	Johnstown, Pa.	4th order—4 Stoves
Trumbull-Cliffs Furnace Co.	Warren, Ohio	1st order—4 Boilers
Trumbull-Cliffs Furnace Co.	Warren, Ohio	2nd order—3 Stoves
Shenango Furnace Company	Sharpsville, Pa.	1st order—4 Stoves
Shenango Furnace Company	Sharpsville, Pa.	2nd order—4 Stoves
Otis Steel Company	Cleveland, Ohio	4 Stoves
Steel Company of Canada	Hamilton, Ontario	1st order—6 Boilers
Steel Company of Canada	Hamilton, Ontario	2nd order—2 Boilers
Donner Steel Company	Buffalo, N. Y.	6 Boilers
Struthers Furnace Company	Struthers, Ohio	5 Stoves
Youngstown Sheet & Tube Company	Indiana Harbor, Ind.	3 Stoves
Central Furnace Company	Massillon, Ohio	4 Stoves
Central Furnace Company	Massillon, Ohio	5 Boilers
Carnegie Steel Company	New Castle, Pa.	6 Boilers
Illinois Steel Company	Gary, Ind.	8 Boilers
Bourne Fuller Company	Cleveland, Ohio	5 Boilers
By-Products Coke Corp.	Chicago, Ill.	4 Stoves
Mystic Iron Works	Boston, Mass.	3 Stoves
Mystic Iron Works	Boston, Mass.	3 Boilers
Trumbull Steel Company	Warren, Ohio	3 O. H. Furnaces
Otis Steel Company	Cleveland, Ohio	1 O. H. Furnace
Bethlehem Steel Company	Johnstown, Pa.	5 Billet Furnaces
Bethlehem Steel Company	Lackawanna, N. Y.	2 Billet Furnaces
Frodingham Iron & Steel Co.	Consett, England	2 Stoves
Frodingham Iron & Steel Co.	Consett, England	1 Soaking Pit
Tonawanda Iron Corp.	North Tonawanda, N. Y.	6 Stoves
Inland Steel Company	Indiana Harbor, Ind.	4 Stoves
Bethlehem Steel Company	Lackawanna, N. Y.	6th order—4 Stoves
Otis Steel Company	Cleveland, Ohio	3rd order—4 Stoves
		6 Boilers
		1 O. H. Furnace
Midland Coke & Iron Company	Granite City, Ill.	3 Boilers
		3 Stoves
Illinois Steel Company	Gary, Ind.	16 Boilers
Weirton Steel Company	Weirton, W. Va.	7 Stoves
		8 Boilers
Carnegie Steel Company	Carrie Furnaces Nos. 1 & 2, Homestead, Pa.	8 Stoves
Carnegie Steel Company	Edgar Thomson Works, Braddock, Pa.	8 Stoves
Tata Iron & Steel Company	Bombay, India	4 Stoves
		4 Boilers
A. M. Byers Company	Girard, Ohio	4 Stoves
Guest Keen & Nettlefolds, Ltd.	Cardiff, England	1 Stove
Bethlehem Steel Company	Sparrows Point, Md.	1 1290 H.P. Boiler
Follansbee Brothers Company	Toronto, Ohio	1 O.H. Furnace
Carnegie Steel Company	Carrie Furnace No. 7, Homestead, Pa.	4 Stoves
Carnegie Steel Company	Youngstown, Ohio, Nos. 4 & 5	8 Stoves
Trumbull-Cliffs Furnace Co.	Warren Ohio	1 Boiler
McKinney Steel Company	Cleveland, Ohio	4 Stoves
Rogers Brown Iron Co.	Buffalo, N. Y.	4 Stoves
Pittsburgh Crucible Steel Co.	Midland, Pa.	1 O.H. Furnace
Ford Motor Company	Detroit, Mich., Rouge Plant	4 Stoves
New Jersey Zinc Company	Palmerton, Pa.	3 Stoves
Bethlehem Steel Company	Sparrows Point, Md.	2 Boilers
Youngstown Sheet & Tube Co.	Mayville, Wis.	4 Stoves

FOR FULL PARTICULARS APPLY TO

American Heat Economy Bureau, Inc.

926-930 Wabash Building, Pittsburgh, Pa.

English address

International Heat Economy Bureau, Ltd.,
Brook House, Walbrook,
London, E. C. 4, England.

Republic Offers
The New and Improved Republic Boiler Meter

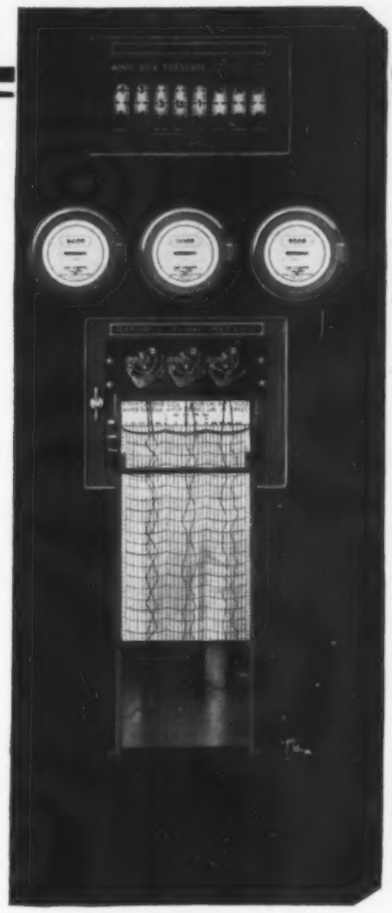
Unified Boiler Operation

REPUBLIC has answered the demand for a closer correlation of boiler operation records thru their development of the **new Republic Boiler Meter.** Realizing that for a proper interpretation of one record, many of the other records must be considered, Republic has designed a new boiler meter which gives a complete survey of boiler operation on one unit panel. The recording of every essential operation on One Wide Strip Chart so that each record is separate and distinct, without confusion of interwoven lines is the Achievement of the Republic Engineers. Each record is a continuous Pen Line and is visible for a period of twenty-four hours. This represents one of the greatest advances in the science of boiler operation made during the past ten years. Accurate integration of CO_2 for ready determination of day averages, shift averages, etc., is another feature which can only be found in the **new Republic Boiler Meter.** The Republic system of electrical operation based on Proven Principles with inherent independence from voltage or cycle changes is embodied in this new boiler meter.

The **New Republic Boiler Meter** gives a continuous record of boiler efficiency by recording and indicating the following data:

1. **Steam Flow—Recording and Integrating.**
2. **Water Flow—Recording and Integrating.**
3. **CO_2 —Recording and Integrating.**
4. **Gas Temperature—Economizer Inlet.**
5. **Gas Temperature—Economizer Outlet.**
6. **Water Temperature—Economizer Outlet.**
7. **Wind Box Pressure.**
8. **Furnace Draft.**
9. **Last Pass Draft.**

Other temperatures may be substituted for those shown above if desired.



REPUBLIC BOILER METER PANEL BOARD

The Republic Turbine Meter is another achievement of the Republic Engineers. It is now possible to obtain a complete survey of Turbine Operations on one unit panel. The Republic Turbine Meter, like the Republic Boiler Meter records all essential records on one Wide Strip Chart. The new Turbine Meter embodies the same electrical principles of operation as are employed in other Republic instruments now used as standard equipment in thousands of plants.

A positive indication of condenser leakage, effect of low vacuum or water rate with a continuous record of the water rate are a few of the special features found on the new Turbine Meter.

Bulletin "Republic Boiler Meter" Mailed on Request

REPUBLIC FLOW METERS COMPANY

EXECUTIVE OFFICES AND PLANT: 2220 DIVERSEY PARKWAY, CHICAGO, ILL.

Branch Offices in 25 Principal Cities

REPUBLIC FLOW METERS

CO_2 Recorders
Draft Instruments
Coal Meters
Recording Pyrometers
Indicating Pyrometers

Republic System

Boiler Meters
Meters, Water and Gas
Meters, Air and Steam
Liquid Level Indicators
and Recorders

PROTECTION!

Losing an Order *and* Gaining a Friend

Now and then we lose an installation of circuit breakers through any one of half a dozen reasons: price, reciprocity, mistaken sales strategy, tactlessness or perhaps through feeling a bit too sure. These losses hurt for the moment, but we invariably find that losing an order often makes a lifelong friend and customer. Moral victories —yes, to be sure—but they don't help meet the payroll of either party.

Usually it happens that when the buyer of "electrical protection" investigates thoroughly the merits of the equipment — not only initial cost but right on down to final economy — he invariably specifies I-T-E Breakers — and sees to it that they are installed.

THE CUTTER COMPANY
ESTABLISHED 1888 — PHILADELPHIA
1826 Hamilton Street

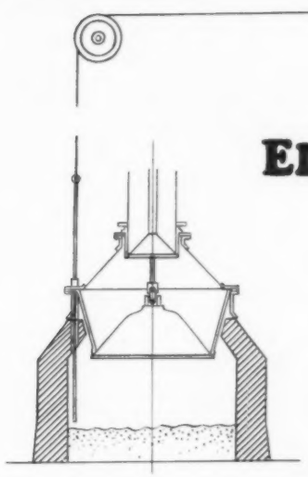
Two 5,000 ampere, 600 volt, I-T-E type "LG," 3 pole solenoid operated Circuit Breakers installed at the new Gould Street station of the Consolidated Gas, Electric Light and Power Company of Baltimore.

Among the interesting features of these big Alternating Current Air Circuit Breakers is the fact that they are electrically trip free at any point of the closing stroke.

This new development is in line with Cutter's policy of continual improvement in design and construction.

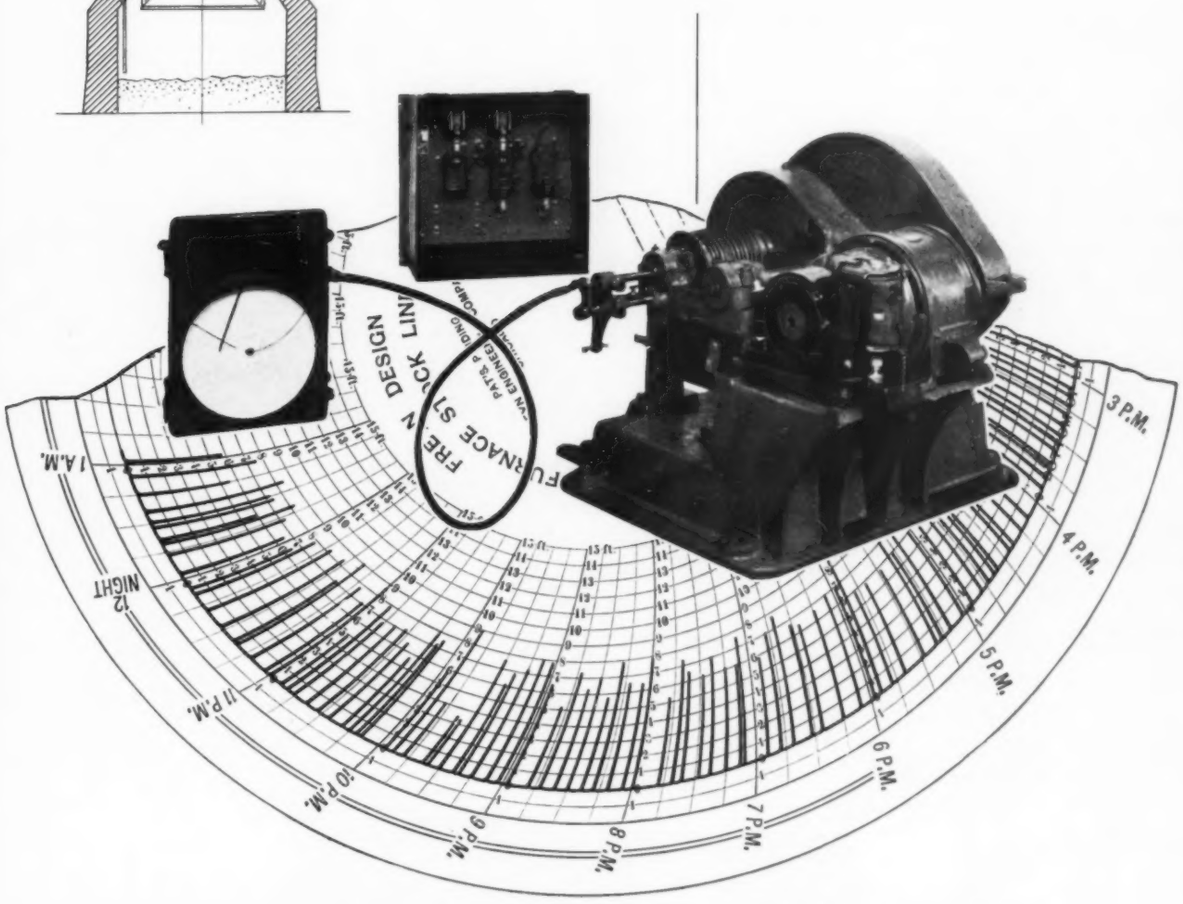
CUTTER

U-RE-LITE I-T-E CIRCUIT BREAKERS



ELECTRIC STOCK-LINE RECORDER FOR BLAST FURNACES

Effective ~ Simple ~ Reliable



Freyn Engineering Company

Consultants - Engineers - Contractors

310 South Michigan Avenue

CHICAGO

EQUIPMENT THAT SERVES — FREYN-DESIGN — CONSTRUCTION THAT ENDURES

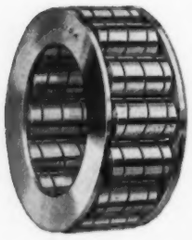
Specify HYATTS *for your* Crocker-Wheeler Motors

Crocker-Wheeler was among the first large builders of crane and mill type motors to furnish Hyatt Roller Bearings.

Excellent performance of Hyatts on changeover jobs at large steel plants has proved the ability of Hyatt bearings to stand the gaff.

Besides Crocker-Wheeler—General Electric, Westinghouse and Shaw are furnishing Hyatt equipment on crane and mill type motors.

And there are more steel plants and other concerns using Hyatts on crane and mill type motors than any other type of anti-friction bearing. The reason is obvious—let a Hyatt engineer present the facts.



Crocker-Wheeler supplies Hyatt bearings on new motors and for changeover on the following motors:

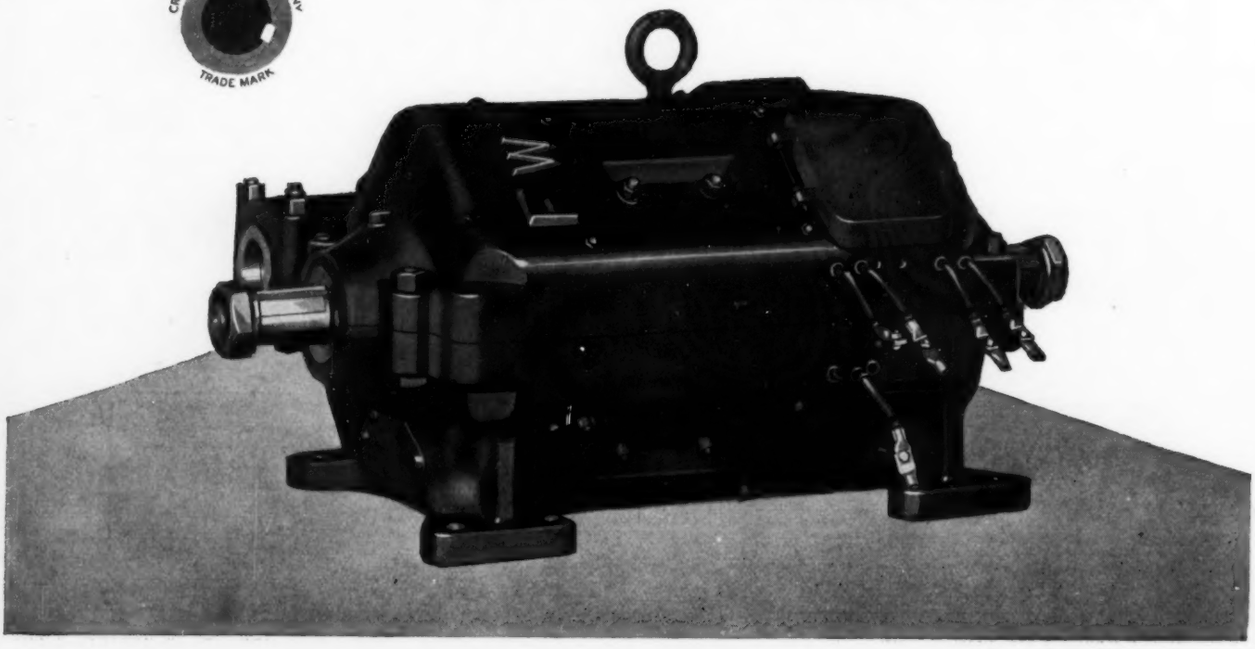
W Series

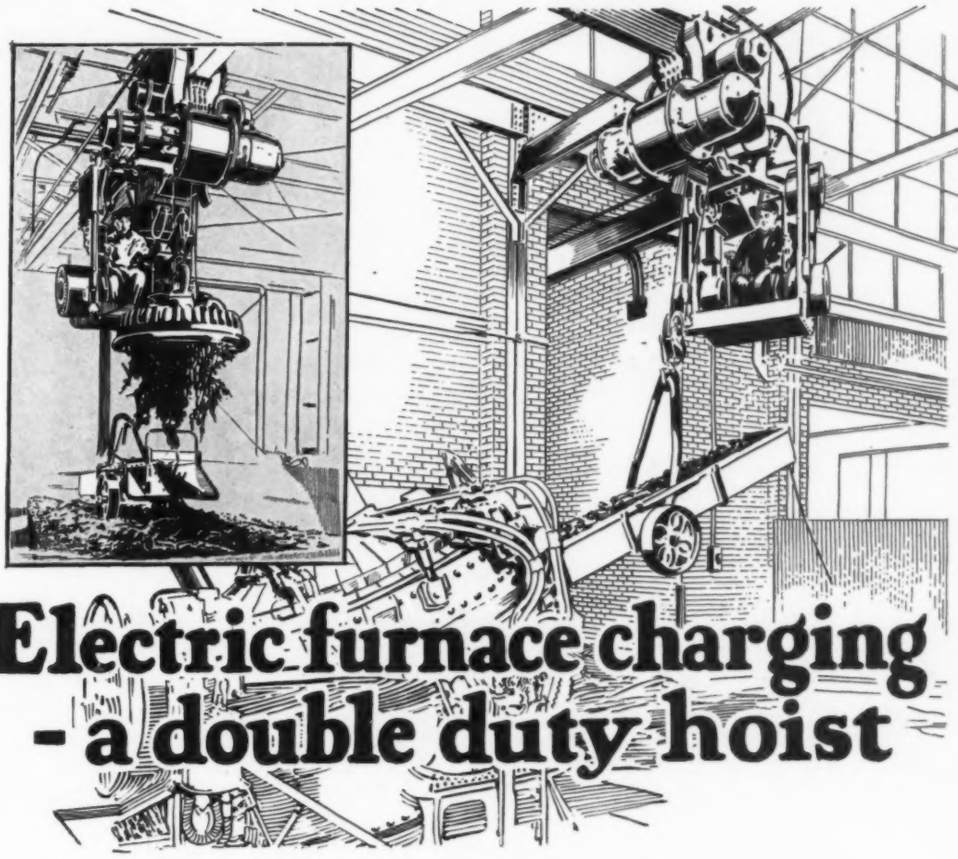
AW *EW*
BW *FW*
CW *GW*
DW *HW*
IW

HYATT ROLLER BEARING COMPANY
Newark Chicago Detroit Pittsburgh Cleveland Oakland
Worcester Philadelphia Charlotte

HYATT
ROLLER BEARINGS

CROCKER-WHEELER COMPANY TRADE MARK





Electric furnace charging - a double duty hoist

Chapman Valve Mfg. Co., Indian Orchard, Mass., "kills two birds with one stone."

It is a Shepard Form 25-23 Cage Operated Electric Hoist used for both furnace charging and metal handling with lifting magnet.

The small view shows the hoist making up a charge; the large view shows it with charging bucket at the door of the furnace.

In charging, the furnace is tilted back and the hoist raises the bucket, similar in shape to a chute, extending the nose into the furnace door and by a jarring movement the charge slides in.

This is typical of the numerous economies that Shepard Electric Cranes and Hoists contribute to foundry practice.

Shepard has served foundries since the earliest days of electric hoist manufacture, and now, as always, Shepard Electric Hoists predominate in America's foundries.

Write for our Foundry and Cupola Charger Bulletin.

SHEPARD ELECTRIC CRANE & HOIST CO.

376 Schuyler Avenue Montour Falls, N. Y.

Branches in Principal Cities

Largest Manufacturer of Electric Hoists in America

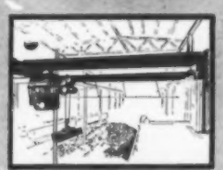
SHEPARD

ELECTRIC CRANES & HOISTS

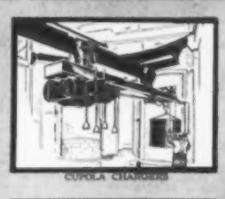
for Metal-working Industries

Shepard Serves Industry With

HOISTS TO 15 TONS

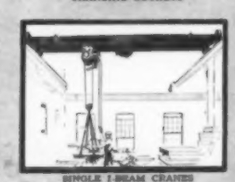


CAGE OPERATED HOISTS—TRANSFER CRANES



CUPOLA CHARGERS

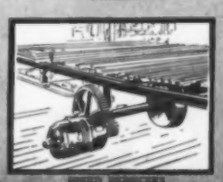
CHARGING BUCKETS



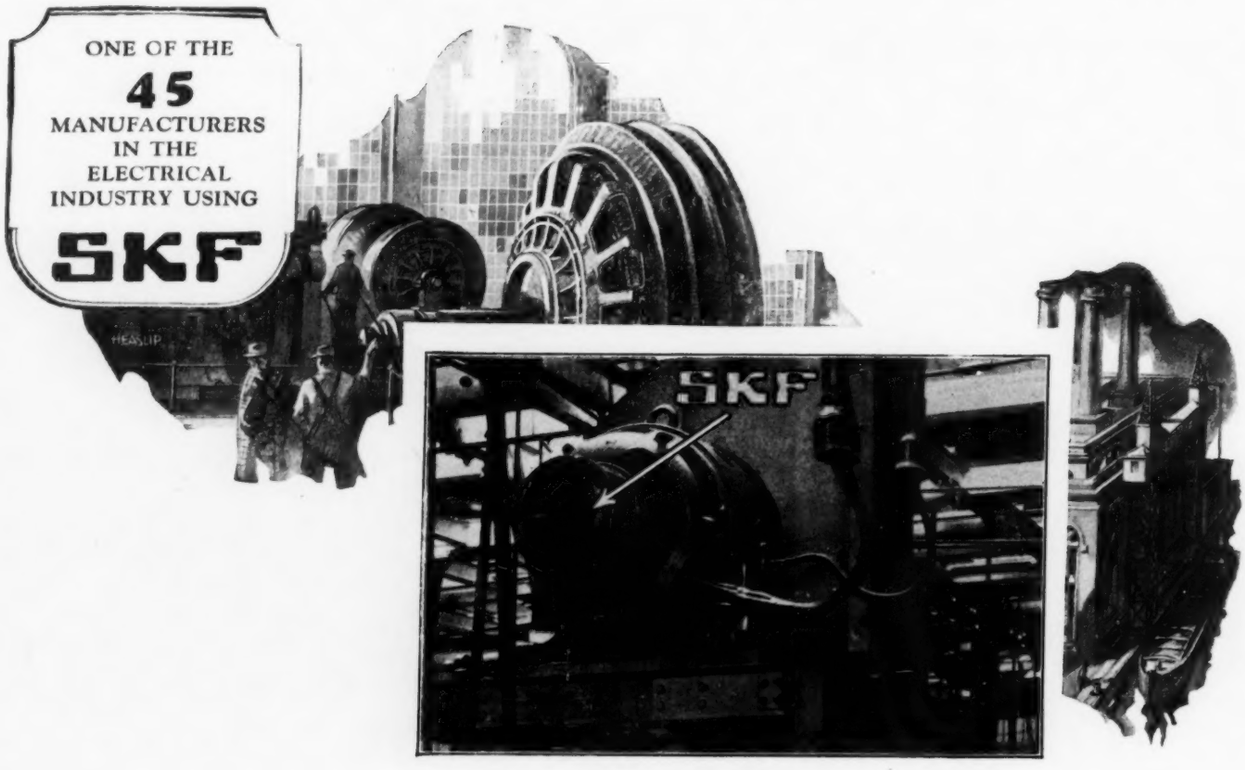
SINGLE I-BEAM CRANES

TRAVELING CRANES

WINCHES



SPEED REDUCERS



SKF-Equipped Motors Save $1,493.10 Per Year

Certified Survey No. 1703 in your Industry or one closely related to it Sent on request.

"IN addition to the operating advantages of the ball bearings, there is a saving in oil and oiling labor amounting to $1,493.10 per year," states the superintendent of a plant in which motors equipped with SKF-marked Ball Bearings range in size from 2 to 200 H.P. and a combined rating of over 2,700 H.P.

"The motors are gone over three times a year. The performance of these motors is really a surprise after being accustomed to babbitt bearing motors which always gave trouble. The work they do and the savings they effect make the ball bearing motors a very profitable investment."

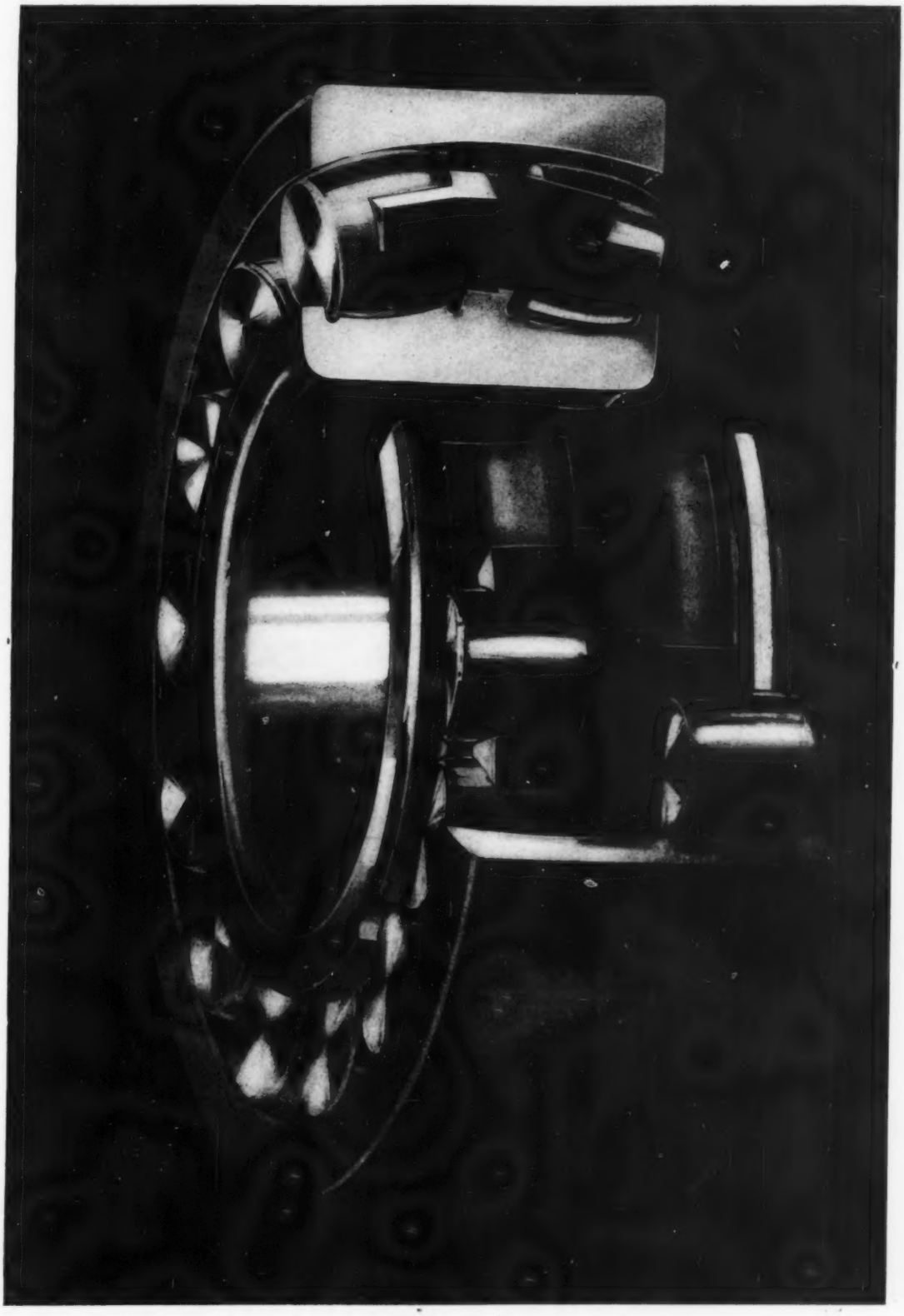
Ask for Certified Survey on this Installation.

SKF INDUSTRIES, INCORPORATED
165 Broadway, New York City

1703

SKF
Puts the Right Bearing in the Right Place

SKF Bearings



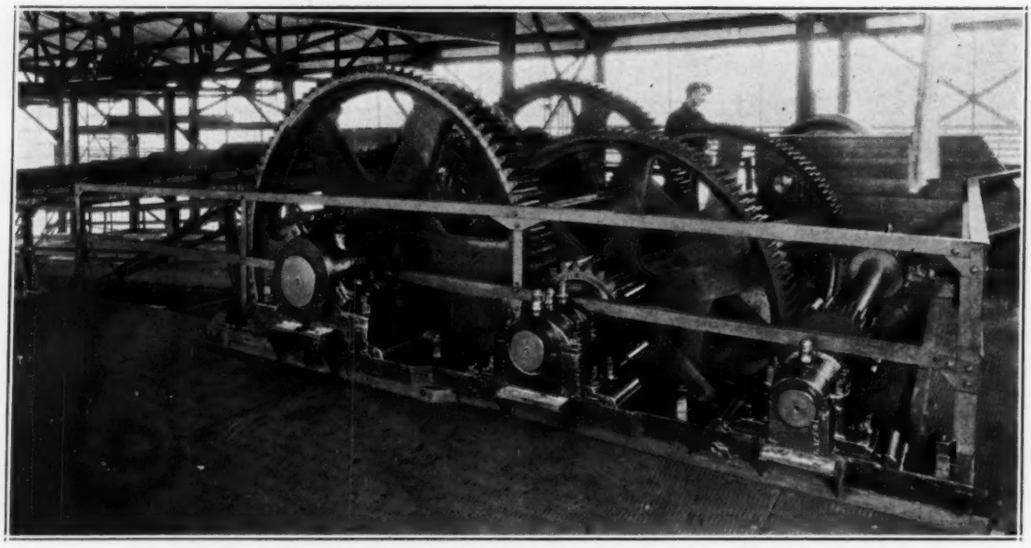
SKF

Check the types of motor applications listed below in which you are interested and return to us. SKF engineers will gladly study your individual problems and submit recommendations without obligation.

Crane motors
Hoist motors
Time table motors
Lift bridge motors
Draw bridge motors
Ore bridge motors
Blast furnace motors
Open hearth charging machine motors
Ingot stripper motors
Ingot buggie motors
Roughing table motors
Elevating roll motors
Gas producer motors
Ash lift motors
Shear table motors
Mixer motors
Cupola motors
Vessel motors
Pug mill motors
Bottom house motors
Exhaust fans
Blowers
Crush motors
Compressor motors
Pumps
Conveyor motors
Transfer table motors
Skew table motors
Cooling bed motors
Lift table motors
Cold saw motors, etc.

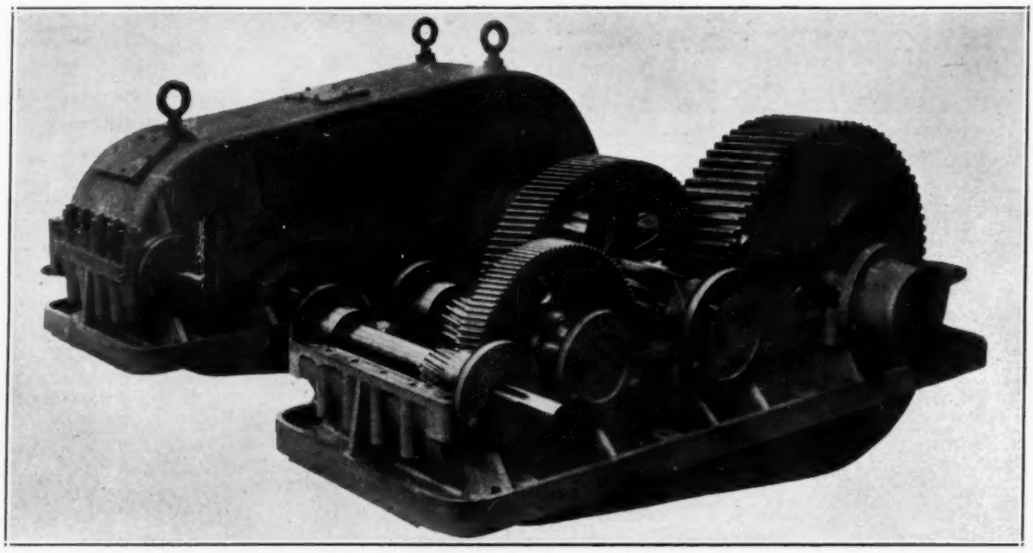
for Steel Mills

A Striking Comparison



This Double Reduction Conveyor Drive was the last word in up-to-dateness and efficiency less than five years ago.

Compare the difference in space occupied by the Nuttall Triple Reduction Drive below, and the increased efficiency of roller bearings, oiling system, helical gears, etc.



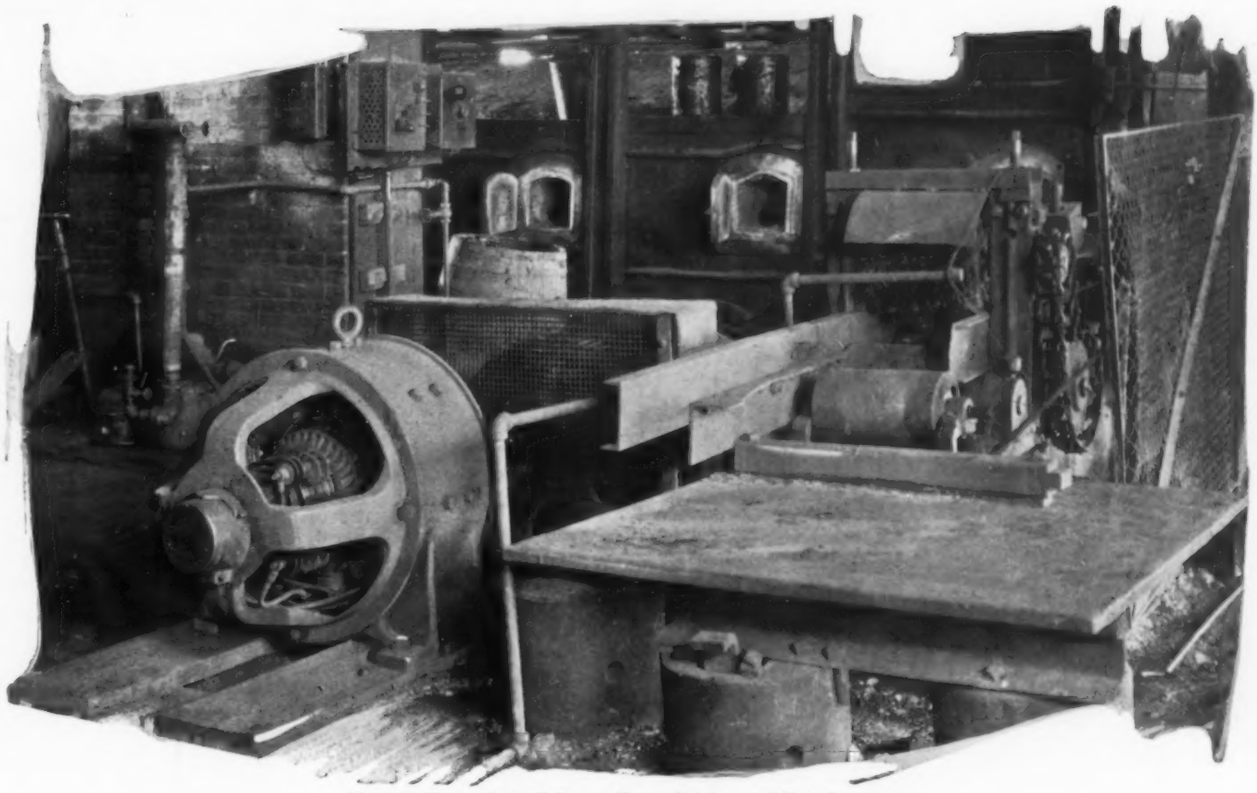
There is hardly a doubt that a Nuttall Reduction Unit would save money on some of your drives.

Philadelphia Office
Westinghouse Bldg.,
30th and Walnut Sts.

R.D. NUTTALL COMPANY
PITTSBURGH PENNSYLVANIA

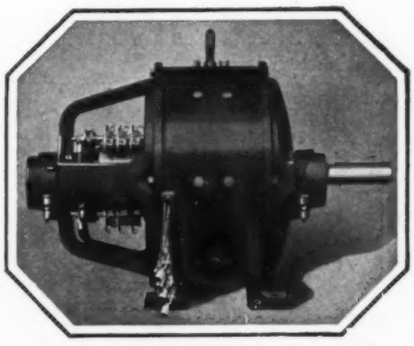
Chicago Office
2133 Conway Bldg.

Canadian Agents—Lyman Tube & Supply Co.
Toronto—Montreal



Type T Heavy Duty Reliance Motor Driving a Billet Conveyor.

A Rough Party



The list of Reliance Motor users is impressive, but even more impressive is the year-after-year repeat purchase record of these buyers who must have equipment that keeps their mills going.

That's steel-making as far as most motor-drives are concerned. It's just natural that the motors must stand a lot of dirt and many hard jolts.

Type T Reliance Motors were cut out for just such work. It was steel-mill duty that mostly influenced their design and manufacture. They have shown by actual results on the job that they are entitled to be termed "heavy duty."

We are always glad to submit detailed evidence of what Reliance Motors are doing in the iron and steel industry.

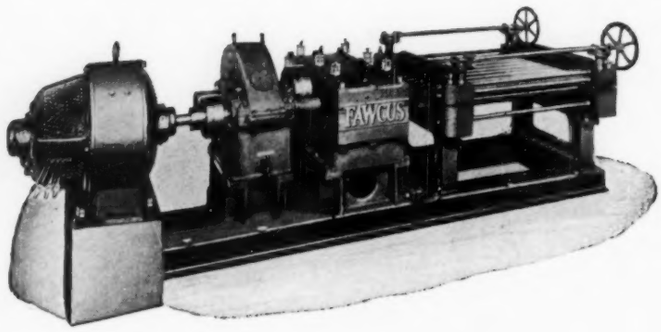
RELIANCE ELECTRIC AND ENGINEERING COMPANY

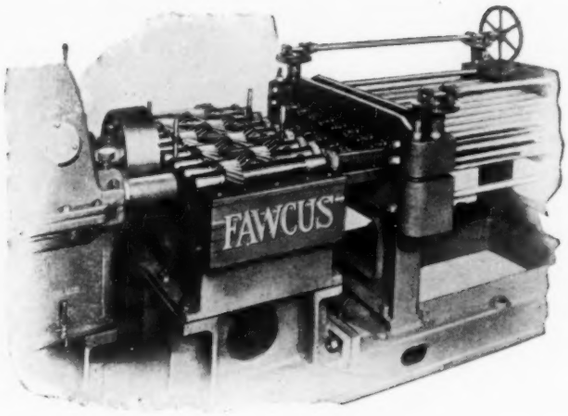
1080 Ivanhoe Road, Cleveland, Ohio

Branches: Boston, New York, Philadelphia, Pittsburgh, Buffalo, Cincinnati, Detroit, Chicago, Birmingham, Ala.

We build both D.C. and A.C. Motors

Type T Heavy Duty RELIANCE MOTORS- Direct Current





Gear Box for Driving Rollers

FAWCUS
Sheet Roller Leveler

Designed for the production of an improved product in cold rolling sheets. The use of Fawcus Herringbone Gears throughout eliminates all vibration and gives a steady, uniform velocity to the rolls, overcoming the marking of sheets, and producing a perfect sheet without buckles, waves or riffles.

The same type of leveler has been developed for strip mill product with shorter rolls and lighter construction, but of the same general design. This machine can be built with the entering rolls adjustable also, while in the machine illustrated the last roll only has independent adjustment.

FAWCUS MACHINE CO.
PITTSBURGH, PA.

REPRESENTATIVES

NEW YORK, N. Y.
Presley Hamilton, 149 Broadway

SAN FRANCISCO, CALIF.
K. W. Eichelberger

MILWAUKEE, WIS.
L. E. Meidinger

BIRMINGHAM, ALA.
G. R. Mueller Co.

PORTLAND, ORE.
Coast Steel Machinery Co.

NEW ORLEANS, LA.
Southern Jobbers Supply Co.

MONTREAL, CAN. Hicks & Newill

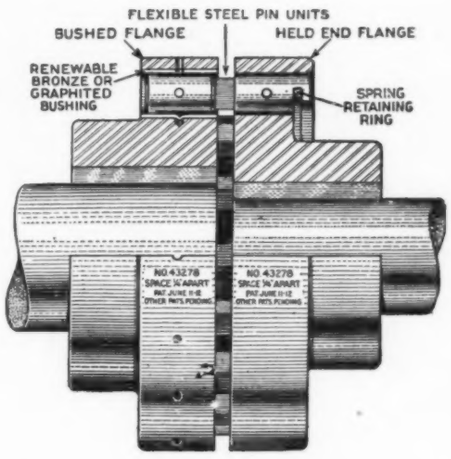
IRON AND STEEL EXPOSITION

JUNE, 1927

Motor Square Garden
PITTSBURGH, PA.

A. H. R. Co. says
Since 1916

"Some of our Francke couplings, installed 10 years ago, are in service today without one cent having been spent for coupling repairs. Because of our experience we have standardized on Francke couplings."



These improved Francke couplings, in small and intermediate sizes, now have forged steel flanges—greater bore and power capacities, lower cost.

FRANCKE
FLEXIBLE COUPLINGS

For Motor, Turbine, Engine Drives

The Francke handles all accidental Misalignments—Out of center in an angular direction and endwise; cushions starting and load shocks; absorbs vibrations; runs in either direction; is noiseless.

In case of excessive misalignment it acts as a safety device saving broken or scored shafts, bearing troubles, etc. However, if more than the usual misalignments are expected, due to non-rigid foundations or for any other reason, two couplings in tandem with an intermediate shaft or a Double, Floating-Ring Type Francke Coupling should be used.

Other Francke Features. Easily mounted, aligned and connected without special tools. All metal, no perishable material. No movement or wear on shaft flanges to cause expensive renewal of complete coupling. Simple and safe.

Ask for Bulletin 37 S

SMITH & SERRELL
Coupling Specialists Since 1912.
64 Washington Street, Newark, N. J.
District Engineers at Pittsburgh, Cleveland, Chicago

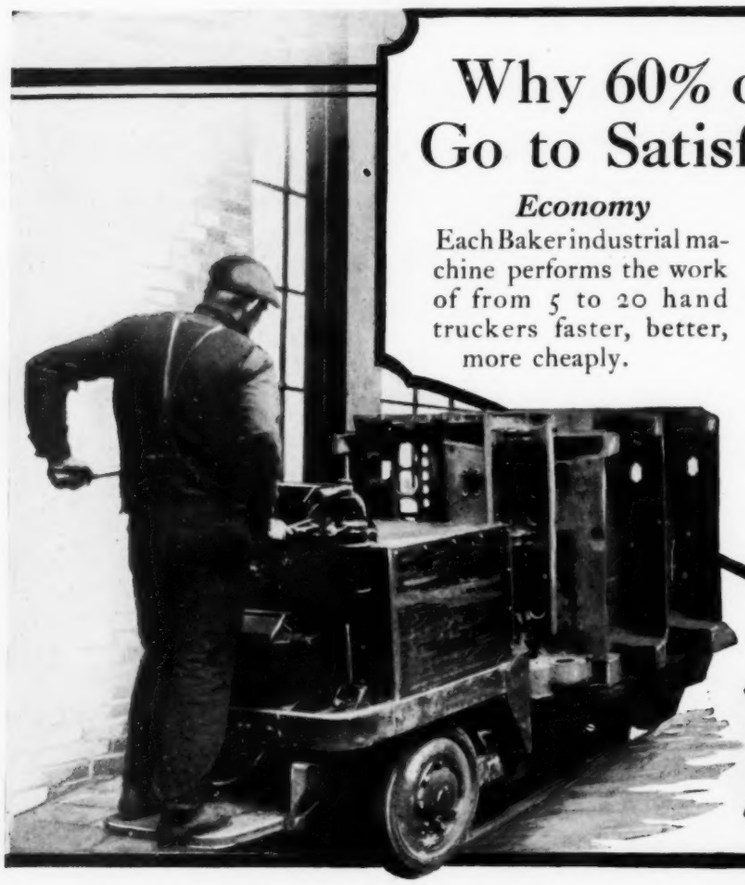
ARE YOU — ?

Protected by Pittsburgh Transformers.
Metered with Sangamo Meters.
Wired with United States Paracore Wire.
Lighted with Fostoria Mazda Lamps.
Illuminated by Holophane Units.
Served in your Electrical Requirements

— BY —

RUMSEY
ELECTRIC COMPANY
1007 Arch Street
Philadelphia

IF NOT—*You Are Overlooking An Opportunity!*



Why 60% of Baker Sales Go to Satisfied Customers

Economy

Each Baker industrial machine performs the work of from 5 to 20 hand truckers faster, better, more cheaply.

Reliability

The Baker factory built motor operates longer at higher overload than any other industrial motor vehicle equipment.

Longevity

Baker's duplex compensating suspension maintains accurate alignment, relieves driving strain and guards against wear and tear.

THE BAKER-RAULANG CO.
2187 West 25th St. Cleveland, O.

ELECTRIC TRACTORS AND TRUCKS
TRADE-MARK REG. U.S. PAT. OFF.
Baker

Joint making with STANDARD Paper Jointing Tubes

STANDARD Jointing Materials

(Paper Jointing Tubes, "Ozite" Insulating Compounds, etc.)

make possible the practical elimination of joint troubles on underground cable systems. Such systems average about one joint for every 300 feet of cable so that it pays, in time and money saved, to eliminate these "weak links." Only the greatest care in the selection and use of jointing materials will produce trouble-proof joints.

Bulletin No. 740 gives complete information

Standard Underground Cable Co.

BOSTON PHILADELPHIA ATLANTA CHICAGO ST. LOUIS SEATTLE NEW YORK WASHINGTON PITTSBURGH DETROIT KANSAS CITY LOS ANGELES SAN FRANCISCO

FOR CANADA: STANDARD UNDERGROUND CABLE CO. OF CANADA, LIMITED, HAMILTON, ONT.

"HOFFMANN"

SHOCK-ABILITY

The sturdy "Hoffmann" Precision Roller Bearing—with its big solid rollers and full-line contact between rollers and races—will stand up under the shocks of sudden overloads, jars and vibration which quickly destroy a less rugged bearing. Yet its Precision Quality is such that it safely carries the highest speeds, smoothly and sweetly.—Write for Catalog 504.

NORMA-HOFFMANN BEARINGS CORPORATION

Stamford — Connecticut

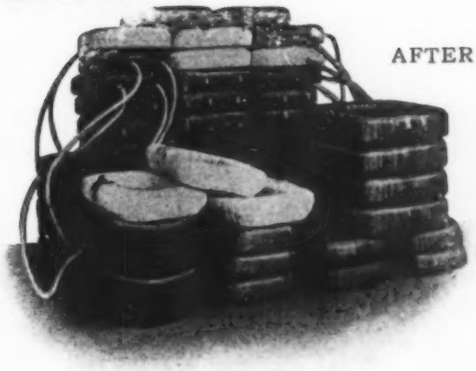
PRECISION BALL, ROLLER AND THRUST BEARINGS

WE REINSULATE BURNED-OUT FIELD COILS

BEFORE

This illustration shows the condition of old burned out field coils as received by us.

AFTER



REINSULATED FIELD COILS

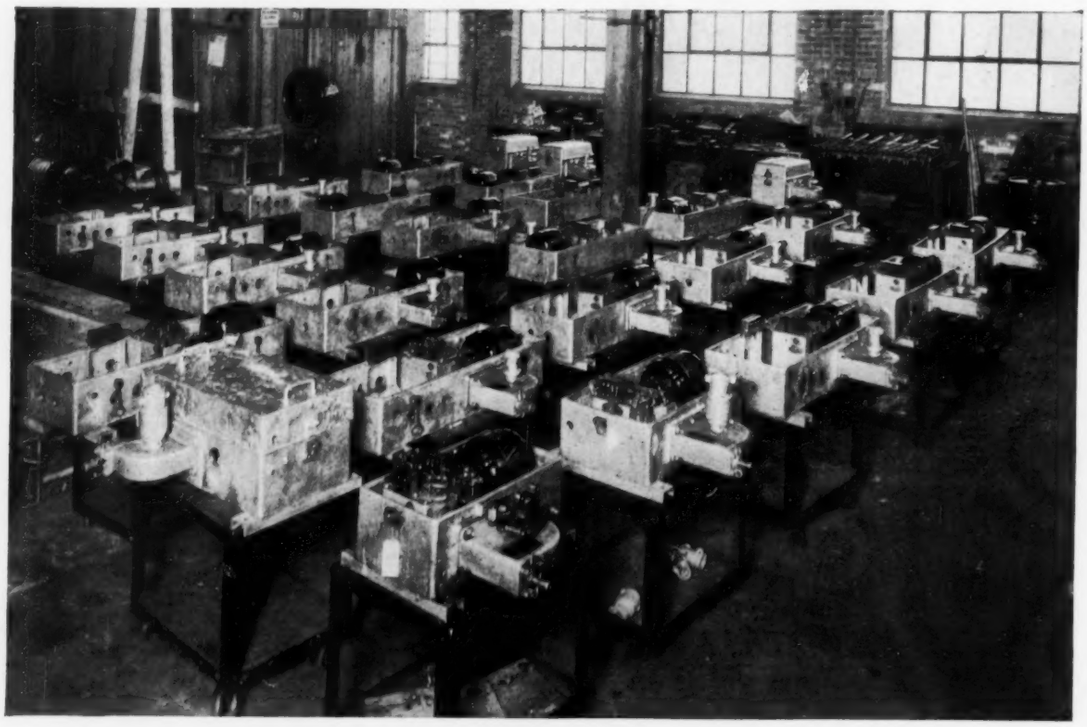
This view shows the same coils after we have removed the old insulation, reinsulated the wire and rewound and finished it into same type of coil.

Prompt Deliveries

Special Attention to Steel Plants

DOUBLEDAY-HILL ELECTRIC CO

Winding and Repair Department **719-21 Liberty Avenue, Pittsburgh**



These Are a Few Motor Operated Mechanisms For Use With Our Gang Type Disconnecting Switches

—

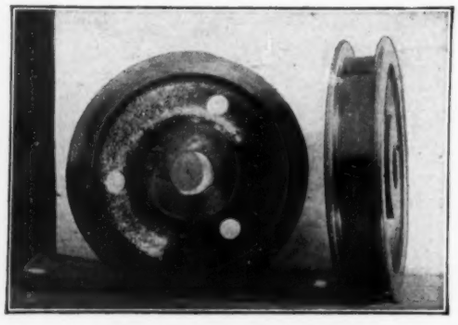
Information Will Be Sent Upon Request.

Our Monthly Magazine is Interesting.

Delta-Star Electric Co

2400 Block, Fulton Street Chicago, Ill.

Are You On Our Mailing List?



"Tool Steel"

CRANE WHEELS

Outlast 5 to 10 untreated steel wheels.

This section cut from a wheel rim shows the hard wearing surface and the tough center.

Keep Your Cranes in Service With Tool Steel Gears and Wheels

TOOL-STEEL QUALITY GEARS AND PINIONS
The Standard of Quality

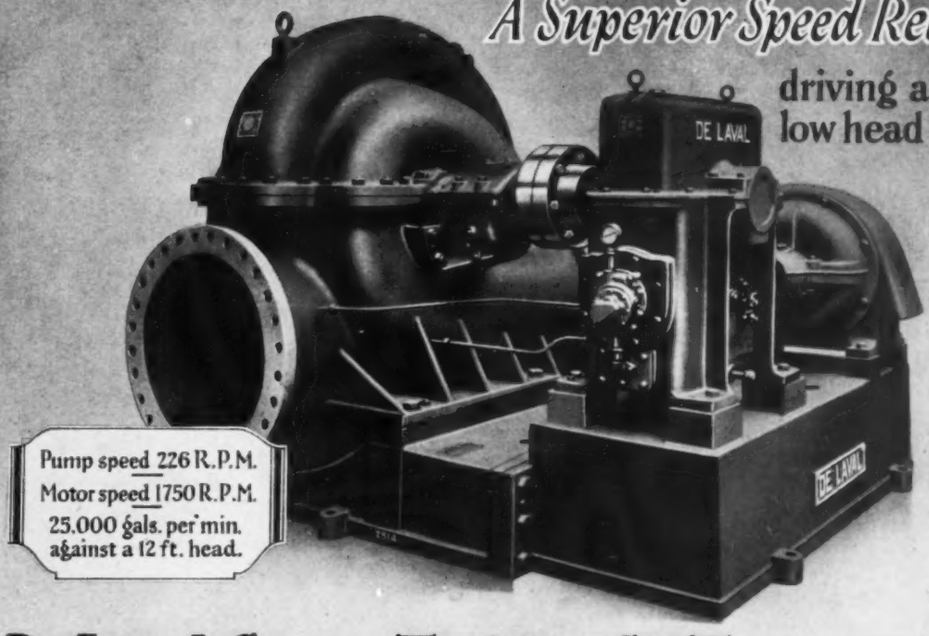
The Tool Steel Gear & Pinion Co.

CINCINNATI, OHIO

De Laval Worm Reduction Gear

A Superior Speed Reducer

driving a large low head pump

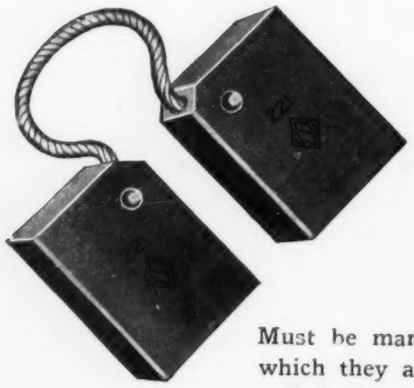


Pump speed 226 R.P.M.
Motor speed 1750 R.P.M.
25,000 gals. per min.
against a 12 ft. head.

De Laval Steam Turbine Co., Trenton, N.J.

THE MARTINDALE ELECTRIC CO.

11730 DETROIT AVE. CLEVELAND, OHIO



Controller Contacts or Carbon Brushes

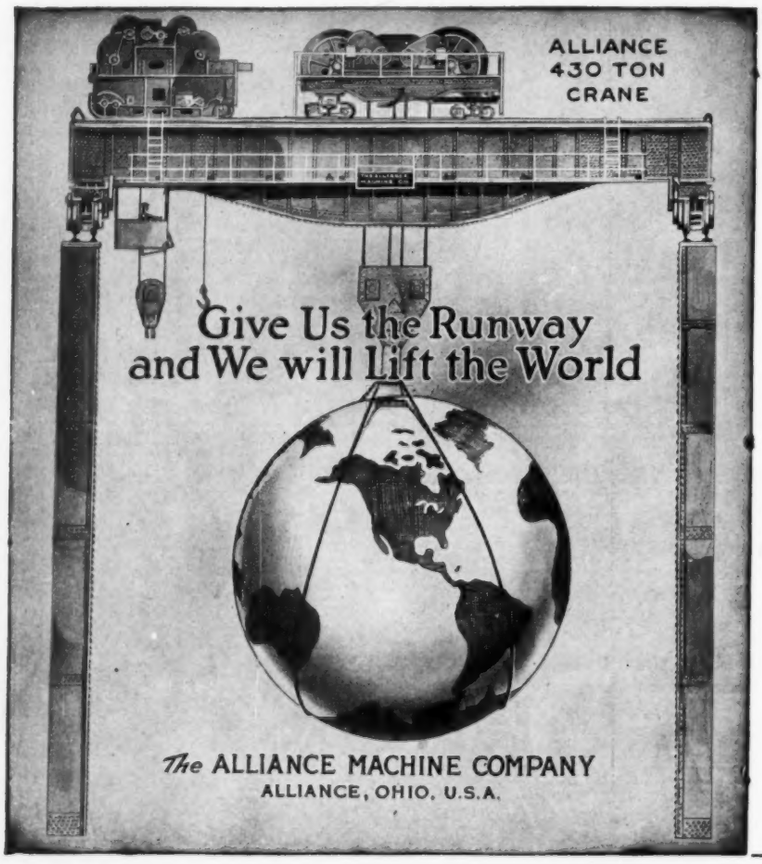
Must be manufactured especially for the machine on which they are to operate. Therefore U.S.G. Brushes and Contacts are made up after the order is received and the rating, etc., of the machine is carefully considered by our brush engineers.

That is why U.S.G. Brushes last longer and give better service.

Write for literature and free samples.

The United States Graphite Co.,

SAGINAW, MICHIGAN



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Largest Builders of the World's Largest Cranes

220 of 100 Tons Capacity and Over

LADLE AND STANDARD CRANES

58	100 tons
2	115 tons
44	125 tons
25	150 tons
1	165 tons
25	175 tons
2	200 tons
1	225 tons
1	250 tons
1	275 tons
3	430 tons

STRIPPING CRANES

8	100 tons
1	125 tons
21	150 tons
15	200 tons
1	Single Ram, 320 tons

COMBINATION CHARGERS AND STRIPPERS

3	100 tons
1	125 tons
3	150 tons
4	200 tons

De Laval Worm Reduction Gear
A Superior Speed Reducer
DE LAVAL
Assures noiseless, positive drive of the heaviest machinery. ~ This gear transmits power from a standard speed electric motor to a coal crusher.
Ask for Catalog "R."
De Laval Steam Turbine Co., Trenton, N.J.

Pittsburgh Transformer Company

Largest Manufacturers of Transformers Exclusively in the United States

Pittsburgh, Pennsylvania

1891 — 1926

MORGAN

Construction Co.

Worcester, Mass., U. S. A.

Designers and Builders of

Morgan Continuous Mills

for

Billets, Sheet Bars, Skelp, Merchant-Bars, Hot-Strip, Rods

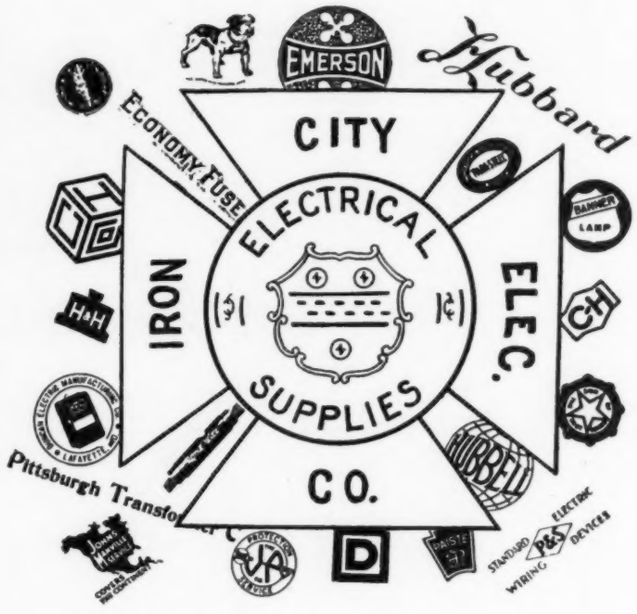
also

Wire Drawing Machines
Producer Gas Machines
Straightening Machines
Isley Reversing Valves
Re-Heating Furnaces
Reducing Gear Units
Shears

Our Engineering Department

is prepared to solve successfully your problems in design or arrangement of plant and equipment from open hearth to finished product

1891 — 1926



The Trade Mark
of the

Iron City Electric Co.

436-38 Seventh Avenue

Pittsburgh, Pa.

REPRESENTING

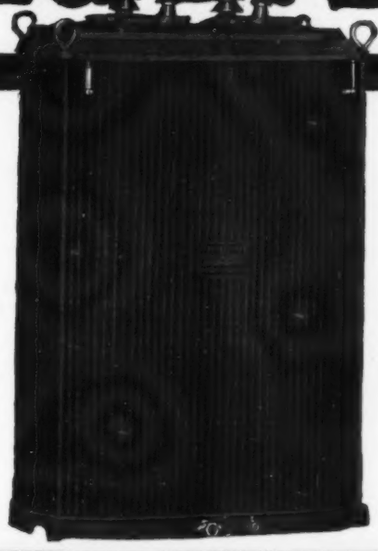
"The House That Service Built"

IS BACKED BY A GROUP OF

TRADE MARKS

Of Well Known Manufacturers Guaranteeing the Quality of the Goods You Receive.

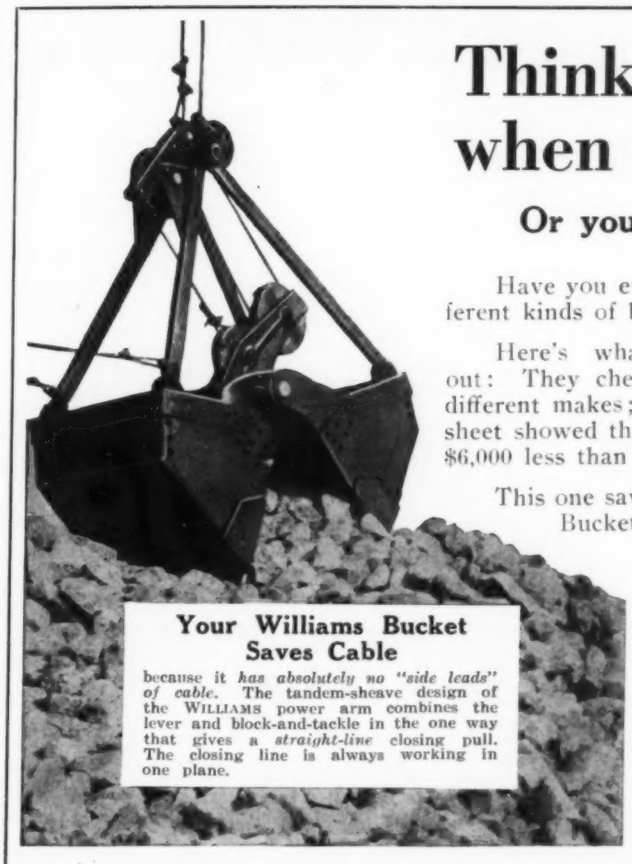
MOLONEY TRANSFORMERS



By past performance Moloney Transformers have earned their present nation-wide approval. Moloney super-quality means longer service and more economical cost. We manufacture transformers exclusively and give our individual attention to your requirements.

Power **Transmission** **Distribution**

MOLONEY ELECTRIC COMPANY
Main Office and Factories: ST. LOUIS, MO.
Sales Offices in Principal Cities



Your Williams Bucket Saves Cable
because it *has absolutely no "side leads" of cable.* The tandem-sheave design of the WILLIAMS power arm combines the lever and block-and-tackle in the one way that gives a *straight-line* closing pull. The closing line is always working in one plane.

Think of CABLE COST when you buy a bucket—

Or you surely will think of it afterward!

Have you ever had the chance to check up the cable costs of different kinds of buckets on the same work?

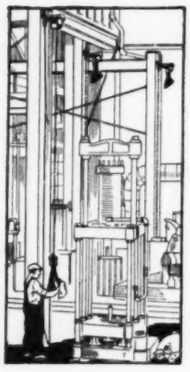
Here's what a well-known Pittsburgh steel concern found out: They checked the cable cost of each of three big buckets of different makes; one of the three was an 11-yd. WILLIAMS. The cost sheet showed that in 18 months the cable cost for their WILLIAMS *ran* $6,000 less than on either of the other two.

This one saving more than paid back the full cost of the WILLIAMS Bucket. We'll be glad to send you details— write us.

G. H. Williams Company
618 Haybarger Lane, Erie, Pa.
Branch Offices: New York, Pittsburgh, Chicago

WILLIAMS
FAST-DIGGING BUCKETS
All Parts Guaranteed Against Breakage

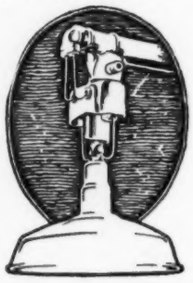
A Clean Reflector is a Worker—
—A Dirty Reflector is a Loafer



Somebody says:

"The purpose of a reflector is to put the light where you want it."

But a dirty reflector will not put the light anywhere—it will do about as much good as an old black hat hung over the bulb.



THOMPSON
SAFETY *Lowering* SWITCH
-or Disconnecting Hanger

Solves the lamp-cleaning problem, because it enables the work to be done with **ease** and **safety** down on the ground—no climbing hazards—no electrical hazards, for the lamp is lowered away from the electric circuit for the cleaning process. The advantage is obvious.

In use in railroad shops and yards, steel mills, foundries, machine shops, cement plants, paper mills, ore and coal docks, armories and countless other places—because they help to make reflectors pay.

Inexpensive and easily included in present lighting systems.

As the cost of all lighting equipment is insignificant compared with the value of the light in carrying on the industry, is it not reasonable to make the installation complete enough to enable it to accomplish its purpose and give the maximum results continuously?

Get Catalog B-26 for the details.

The Thompson Electric Co.

1438 W. 9th St. Cleveland, Ohio, U. S. A.

"CIRCLE T"

"R. M." Type Motor Starting Switches

For Use With Thermal Cutouts.

"R.M." Switch Mounted on a Direct Driven Grinder.

One Switch for all Voltages (110-550)

and yet the size is no greater and perhaps even smaller than that of the ordinary 250-volt motor starting switch.

(Box 11¾"h. x 7⅝"w. x 5⅛"d.)

Other Features

1. Box cover is interlocked with the operating handle.
2. Double Break—reduces arcing.
3. Barriers effectively prevent sideflare and arcing to the box.
4. Throw ON to start—Throw OFF to stop—(thermal cutouts take care of the heavy starting current, but protect against a continued overhead.)

No. 93361
"R.M." Type

Have you a copy of Motor Starting Switch Circular No. 2?

THE TRUMBULL ELECTRIC MFG. COMPANY

Plainville, Conn.

NEW YORK 114 Liberty St.
SAN FRANCISCO 595 Mission St.
CHICAGO 2001 W. Pershing Road
PHILADELPHIA
BOSTON
JACKSONVILLE, FLA.

GUMELE YAMA GRESI

Every real kaffir boy aspires to some day be a gumele yama gresi—or cattle herder.

"Why," you ask, "does he aspire to such a lowly job?"

The answer to which is that this isn't a lowly job when viewed through the kaffir's eyes.

He has never seen a better job.

That is why we are quite tolerant with an operator who says, "I'm perfectly satisfied with these '5 & 10' carbon brushes—they do a good job."

Right away quick we realize that he has never experienced Morganite service—so we smile just a trifle.

Morganite

Main Office and Factory
519 West 38th St., New York

DISTRICT ENGINEERS AND AGENTS

Pittsburgh, Electrical Engineering & Mfg. Co., 909 Penn Avenue.
Cincinnati, Electrical Engineering & Mfg. Co., 607 Mercantile Library Building.
Cleveland, Electrical Engineering & Mfg. Co., 422 Union Building.
Baltimore, O. T. Hall, Sales Engineer, 437-A Equitable Building.
Revere, Mass., J. F. Drummey, 75 Pleasant Street.
Los Angeles, Special Service Sales Co., 502 Delta Building.
San Francisco, Special Service Sales Co., 222 Underwood Building, 545 Market Street.
Toronto, Can., Railway & Power Engineering Corp., Ltd., 101 Eastern Ave.
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Winnipeg, Can., Railway & Power Engineering Corp., Ltd., P. O. Box 325.

1200 ampere, two pole independent arm with "interlocked trip."

A New Bulletin

Every man who is interested in the latest developments in the circuit breaker line should send for new Bulletin AK-530 just off the press.

The information in this Bulletin is complete and convenient. It is in get-at-able shape. Just what the busy man needs.

Your copy is waiting for you. Use the coupon.

"Over thirty years' experience is back of ROLLER-SMITH"

ROLLER-SMITH COMPANY
Electrical Measuring and Protective Apparatus

MAIN OFFICE
2131 Woolworth Bldg., New York

WORKS
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Gentlemen:

Please send me ROLLER-SMITH Bulletin No. AK 530.

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It hurts

—like dentistry when you've been "stung" on carbon brushes that chatter and spark and lose horsepower at every turn of the commutator.

Every Stackpole brush is stamped STACKPOLE to protect the discriminating user of carbon brushes—every brush with the STACKPOLE trade-mark is a guarantee of quality and uniformity—backed by the faith and integrity of the manufacturer.

Have your brush requirements analyzed by Stackpole experts. They can give you facts that will put your power machinery on a new efficiency basis.

Stackpole Carbon Company

St. Marys, Penna.

Stackpole carbon brushes

No More Stretching Sheets

What would it be worth to you if you could do away with this operation? Regular day-in and day-out production of the smooth, even-gauge sheets you have always wished for is made possible by

ROLLWAY BEARINGS

On Roll Necks

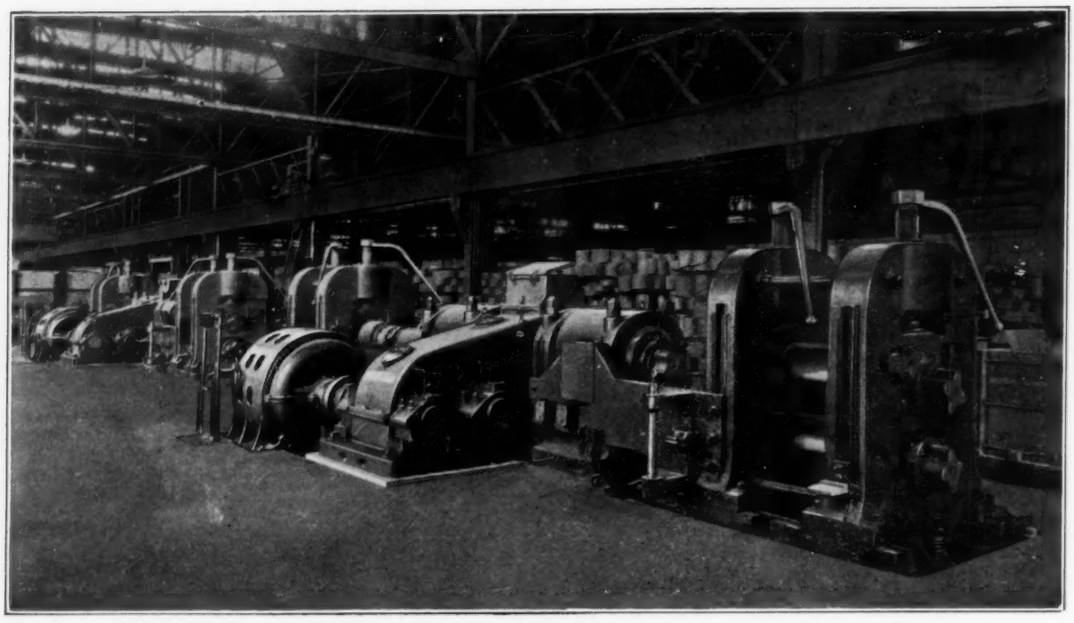
In addition to doing away with the stretching operation, there is considerable saving in maintenance cost of the mill itself.

Write us, informing us what your proposition is and we will have qualified representative call on you.

Rollway Bearing Co., Inc.

Syracuse, New York.

ALLIS-CHALMERS



Synchronous Motor Rolling Mill Drive

The above illustration shows two of five synchronous motors driving rolling mills in the plant of Michigan Copper & Brass Co. The motors are rated 800 H.P., 4600 volts, 60 cycle, 3 phase, 720 R.P.M. and are giving excellent satisfaction. These motors are capable of sustaining heavy overloads and have proved their ability to do so.

PRODUCTS:

Electrical Machinery
Gas Engines
Steam Engines
Steam Turbines
Condensers
Oil Engines
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Saw Mill Machinery
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Farm Tractors
Power Transmission Machinery

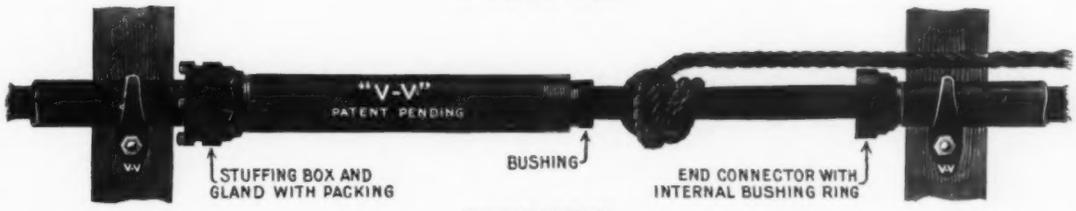
ALLIS-CHALMERS MANUFACTURING CO.
MILWAUKEE, WIS. U.S.A.

"V.V."

STRAIGHT LINE PULL AND SPLICE FITTINGS

Waterproof—Vaporproof

TYPE AP



OPEN VIEW

Designed to give a straight through pull in the open air on long horizontal and high vertical pulls.

Permit a straight line pull, thereby greatly facilitating the attaching of the pull "sling."

Superior to pull boxes, as the opening in the conduit may be varied as desired from one to nine feet.

Neat and symmetrical in appearance.

Absolutely water and vapor tight.

Made of cast iron, black or galvanized finish, in standard conduit sizes: 1" to 6" inclusive.

Each outfit consists of an End Connecting Terminal with internal bushing (into which the "sliding conduit sleeve" screws), a Stuffing Box Fitting complete with Gland and Packing (which fastens to one end of the sliding conduit sleeve) and a Special Bushing for the end of the main line conduit.

CLOSED VIEW

V. V. FITTINGS COMPANY

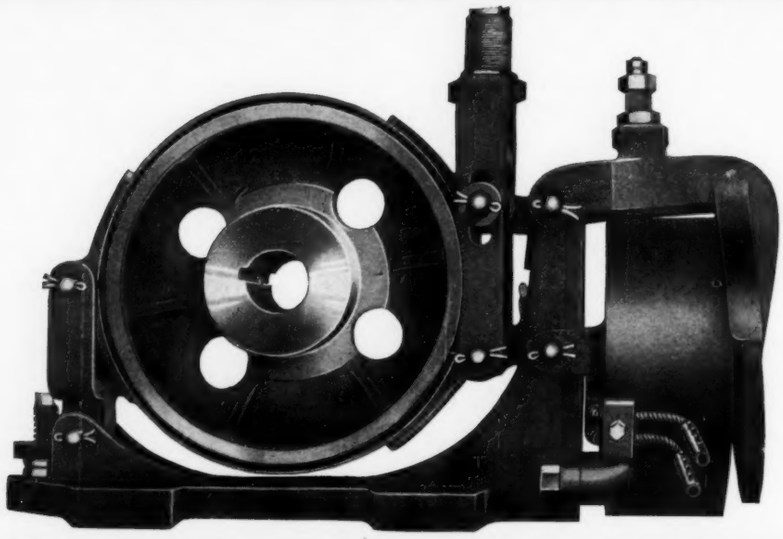
MAIN OFFICE AND WORKS

PHILADELPHIA, U. S. A.

New York Office: 50 Church Street **Chicago Office and Warehouse:** 710 West Jackson Blvd.

THE "3C" BRAKE

PROGRESS



The Clark "3C" Brake is of the split-band type. It combines band-brake efficiency with shoe-brake characteristics.

Is equally effective in either direction of rotation. Has shown exceptionally low maintenance cost.

THIS BRAKE IS NOW IN USE IN OVER TWENTY-FIVE DIFFERENT PLANTS AND HAS BEEN GIVEN UNQUALIFIED APPROVAL IN EVERY CASE.

For Further Information
Write for Bulletins 102 and 102-A.

THE CLARK CONTROLLER CO.

CHICAGO 53 W. JACKSON BLVD. R. E. BOCK DIST. MANAGER

DETROIT FRANCIS PALMS BLDG. L. H. ALLISON CO. DIST. MANAGER

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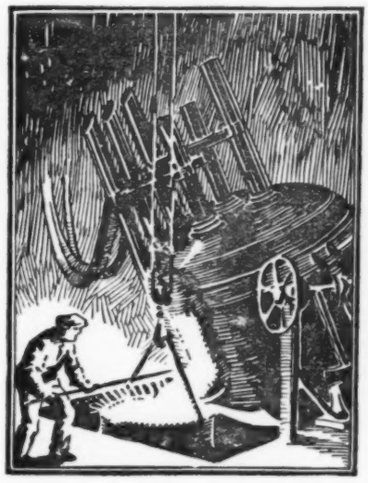


"Do It Electrically" with Central Station Power

THE next time the old fuel-fired furnace is jamming up the works, slowing up production and increasing overhead, give a thought to the heating and power operations in your plant that can be accomplished more economically and more quickly if you "do it electrically".

ELECTRICITY IN YOUR PLANT WILL

Speed up Production

Keep the Quality of your Product Uniformly High

Reduce Rejections and Errors

Turn your Power Worries over to the Central Station

Progressive industrial men are looking more and more to electricity as the solution of industrial power problems. And by experimentation they have found that hooking up with central stations is cheaper in the end and much more satisfactory than generating power in each individual plant.

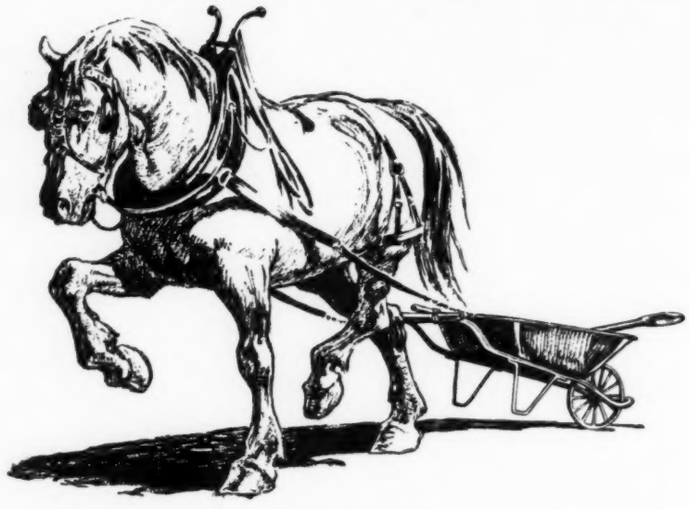
Our power engineers are at all times available for consultation on your power problems.

DUQUESNE LIGHT COMPANY

435 SIXTH AVENUE **PITTSBURGH, PA.**

"Live in and Expand Your Business in Greater Pittsburgh"

Why use horses to pull wheelbarrows?



USING a horse to pull a wheelbarrow is a ridiculous waste of power, and so is using a huge motor to run a varying number of small machines. That's the function of individual drive with the small motor.

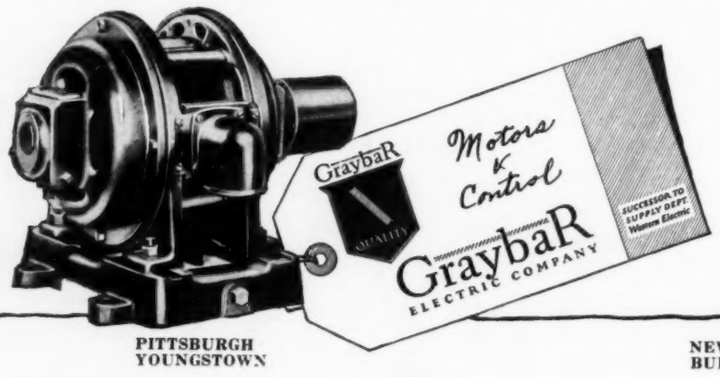
Each machine operated with an individual motor is a separate production unit that can be placed where it is most efficient. Also, proper speed regulation on each machine is a simple matter with individual drive. Power is saved and turned into useful work not only by virtue of direct drive but even more by the economy of operation that's built right into every motor that comes to you from Graybar Electric.

Your nearest Graybar distributing house can furnish prompt help on any of your power problems.

GraybaR

ELECTRICAL SUPPLIES

Successor to *Western Electric* Supply Dept.



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YOUNGSTOWN

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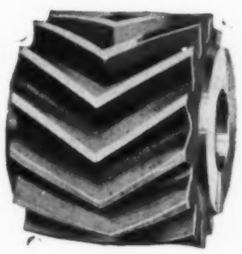
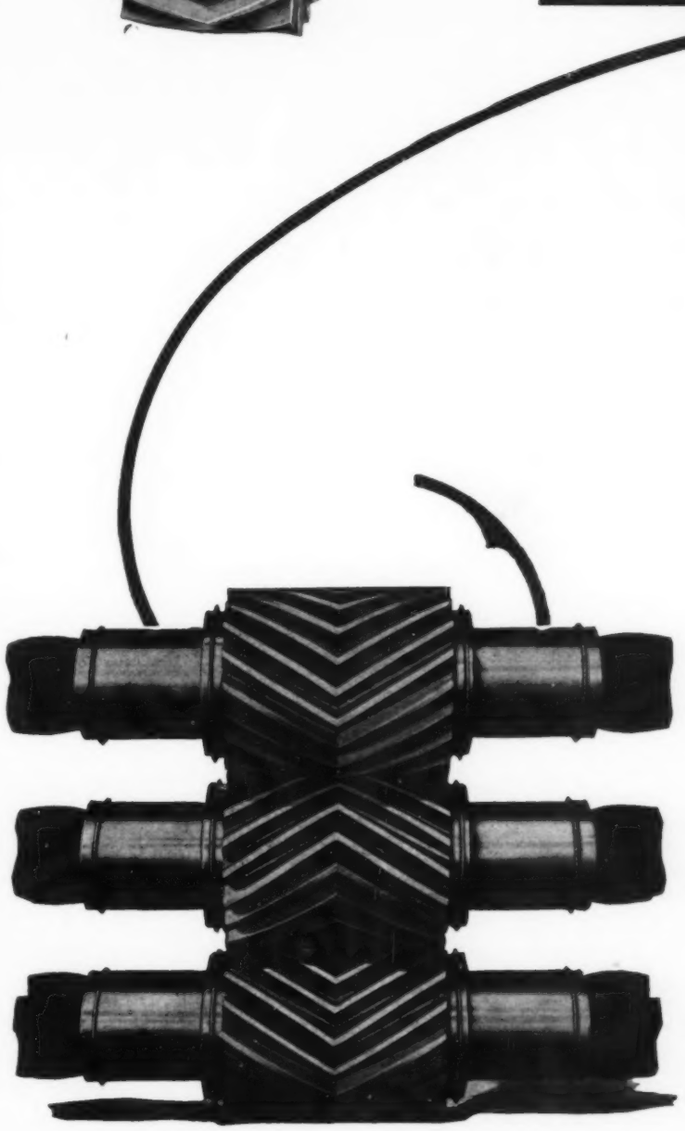
BUFFALO



Herringbone Gears *without a Gap!*



Farrel Sykes Gears

Embody every improvement of double Helical Gears known to Engineers.

The continuous form of teeth of a Sykes gear is one of a number of factors contributing to their success. It is an important factor since it provides from 15% to 40% more bearing surface and 50% more strength.

Other factors, not so apparent, are: the accuracy of tooth division and profile; the 30° helical angle which ensures the best conditions of tooth overlap; the increased addenda of driving pinions resulting in less tooth friction and higher efficiency; and the care in design, application and manufacture which has always been associated with the name of "Farrel."

It follows, therefore, that smooth, silent, vibrationless operation together with great resistance to breakage and wear are characteristics of Farrel-Sykes gears.

Specify
The Gear With a Backbone

Farrel Foundry & Machine Co.

PLANTS at ANSONIA, CONN., AND BUFFALO, N. Y.

BRANCH OFFICES

New York, N. Y.	79 Wall St.
Boston, Mass.	914 Little Bldg.
Cleveland, Ohio	802 Swetland Bldg.
Pittsburgh, Pa.	649 Union Trust Bldg.
Havana, Cuba	Edificio, Canada
Mexico City, Mexico	Apartado 2361, 215 Cidosa Bldg.
San Juan	Porto Rico

"LE CARBONE"
CARBON BRUSHES

Standard of Quality
And Uniformity

They are supplied not alone to suit type of machine, but your operating conditions.

Guaranteed Without Argument.

Real Engineering Service.

W. J. Jeandron, Hoboken Factory Terminal, Building F, Fifteenth St., Hoboken, N. J.

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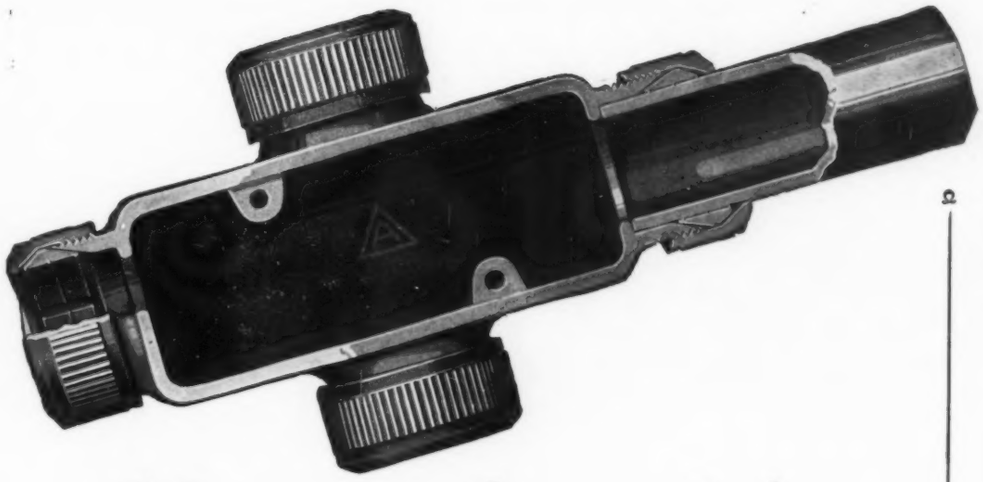
San Francisco Office, 525 Market St.
W. R. CATCHING, Sales Engineer

Chicago Office, 1657 Monadnock Block
A. M. RAMSEY, Sales Engineer

Canadian Distributors: Lyman Tube & Supply Co., Ltd.
Montreal and Toronto



More profit per job using improved No-Thread Unilets

Besides material cost, labor is the big item on any wiring job. Cutting down on labor *saves time* and *increases profits on every job.* By using improved No-Thread Unilets thousands of electrical contractors are doing away with the former necessity of conduit threading—the operation for which there is no compensation.

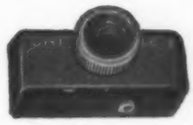
The sectional view above illustrates the simple features that take the time from an unnecessary operation and add it to the profit column of the job.

By tightening the knurled nut, the inner steel ring is compressed onto the conduit. The inside surface of this ring has three projecting beads that pierce through the conduit enamel making a metal to metal contact, thus assuring a perfect running ground.

At no place on the entire job is the conduit weakened by thread cutting—the joints are mechanically secure and electrically sound. Besides the No-Thread feature, these fittings, being made of malleable iron, are stronger than cast iron fittings. More working space makes for speedier wirings and effects a still greater saving of time on each job. All standard types of rectangular Unilets are made with the No-Thread feature in addition to the regular line of standard threaded fittings. Covers are interchangeable.

Full information and specifications will be sent upon your request.

TYPE "NTA"



TYPE "NTB"

TYPE "NTC"

TYPE "NTE"

TYPE "NTLB"

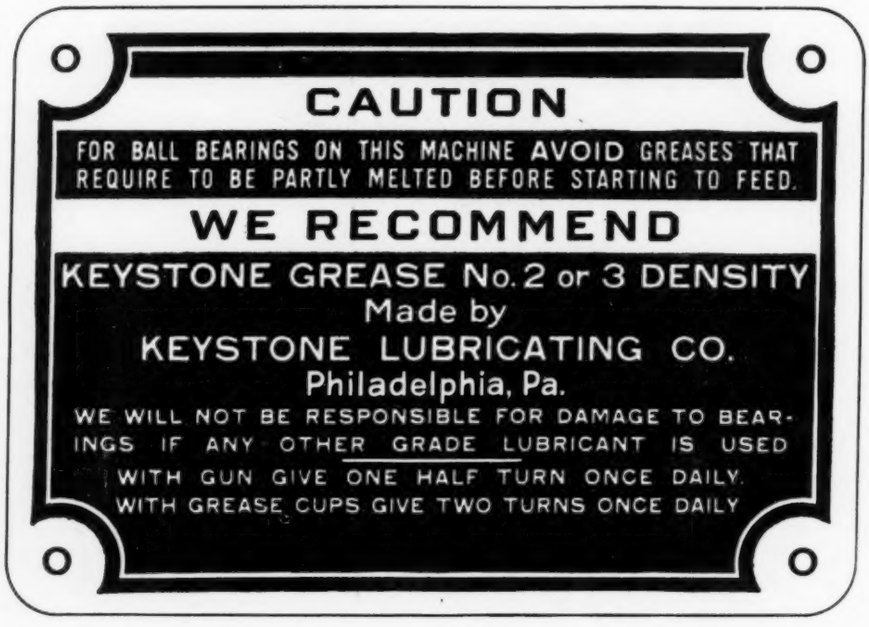
TYPE "NTLL"

TYPE "NTT"

APPLETON ELECTRIC COMPANY

1703 *Wellington Avenue* · *Chicago, U. S. A.*

New York—150 Varick Street Los Angeles—340 Azusa Street


CAUTION
FOR BALL BEARINGS ON THIS MACHINE AVOID GREASES THAT REQUIRE TO BE PARTLY MELTED BEFORE STARTING TO FEED.
WE RECOMMEND
KEYSTONE GREASE No. 2 or 3 DENSITY
Made by
KEYSTONE LUBRICATING CO.
Philadelphia, Pa.
WE WILL NOT BE RESPONSIBLE FOR DAMAGE TO BEARINGS IF ANY OTHER GRADE LUBRICANT IS USED
WITH GUN GIVE ONE HALF TURN ONCE DAILY.
WITH GREASE CUPS GIVE TWO TURNS ONCE DAILY

The brass plate reproduced above, which is a typical recommendation of Keystone Grease, is attached to every unit produced by a prominent manufacturer of woodworking machinery. His interest is in safe and efficient operation

—and *Your* interest:

Can the user of machinery afford to be any less careful about its bearings than the manufacturers who build it?

KEYSTONE TRADE MARK Reg. U.S. Pat. Off. GREASE

KEYSTONE LUBRICATING CO.

21st and Clearfield Streets · · Philadelphia

Established 1884

Morgan—Youngstown—Timken

A famous constructor like the Morgan Engineering Company—a great institution like The Youngstown Sheet and Tube Company—an ultra-modern mill like the new Youngstown development at Indiana Harbor—and you safely assume that Timken Bearings will play a prominent part in the engineering.

It is hardly ever otherwise today in the greatest industrial projects by the greatest equipment builders, for the greatest machinery users.

Throughout all the Morgan cranes in this new mill, Timken Bearings are used to improve design and assembly, to save power and lubricant, to increase acceleration, daily capacity, and endurance. Timken economies could hardly have better sponsors than Morgan and Youngstown.

THE TIMKEN ROLLER BEARING CO., CANTON, OHIO

Technical information regarding bearing sizes and their mountings can be secured from The Timken Roller Bearing Service & Sales Company's Branches located in the following cities: Atlanta, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Dallas, Denver, Detroit, Kansas City, Los Angeles, Memphis, Milwaukee, Minneapolis, Newark, New York, Omaha, Philadelphia, Pittsburgh, Richmond, St. Louis, San Francisco, Seattle, Toronto, Winnipeg

TIMKEN *Tapered Roller* **BEARINGS**

For Lighting *from* The Side

Cat. No. 5525

Efficient, Low-Cost, Long-Service Lighting for Mills and Foundries

In mills and foundries there are many places where the lighting is inadequate, because general illumination on an effective scale is impossible.

Here is where the Benjamin Elliptical Angle Reflector is especially useful. It delivers a flood of light on both vertical and horizontal surfaces, illuminating the work, but keeping the source of light from interfering with vision.

Benjamin Shock Absorbing Socket

Sturdy in every particular, reflecting surface and outside finished with Crysteel Porcelain Enamel. Fitted with heavy X-type fittings. And for places where heavy machinery sets up destructive vibration, the shock-absorbing socket protects reflector and lamp against the hardest service knocks.

Benjamin Elliptical Angle Reflector

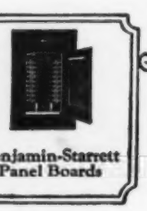
For mounting in places where overhead suspension is impractical. Builds up a strong even illumination on both horizontal and vertical surfaces.

Our nearest office will gladly furnish full information

Benjamin Electric Mfg. Co.

New York: 247 W. 17th St. | 120-128 So. Sangamon St. Chicago | **San Francisco:** 448 Bryant St.

Manufactured in Canada by the Benjamin Electric Mfg. Co. of Canada, Ltd., Toronto, Ontario



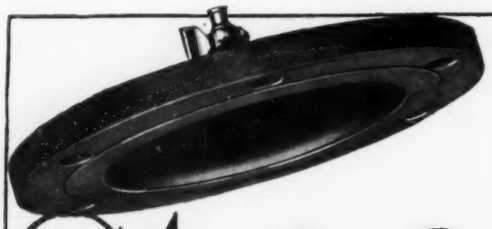
Benjamin-Starrett Panel Boards

BENJAMIN

TRADE MARK

Benjamin Industrial Howlers

BUSS FUSES
TRADE
BussFuses
MARK
APPROVED IN ALL TYPES AND SIZES
Buss Fuses Keep Century "a-Running"
The makers of the renowned Century Motors find that BUSS Renewable Fuses meet the most exacting tests of service to give them complete electrical protection.
The illustration is an interesting view of one of their electric furnace rooms. The circuit controlling these furnaces as well as the multiplicity of other circuits throughout their plants are being protected by BUSS Renewable Fuses.
The testimony of thousands of such satisfied users and the simple correctness of BUSS design are in themselves convincing proof of BUSS superiority—but only the actual test of service will show you the true saving in time, labor and money that an installation of BUSS renewable Fuses will give you. Specify them on your next requisition.
A sample is yours for the asking.
BUSSMANN MFG. CO. ST. LOUIS MO.
4 parts and the Link
That's All!

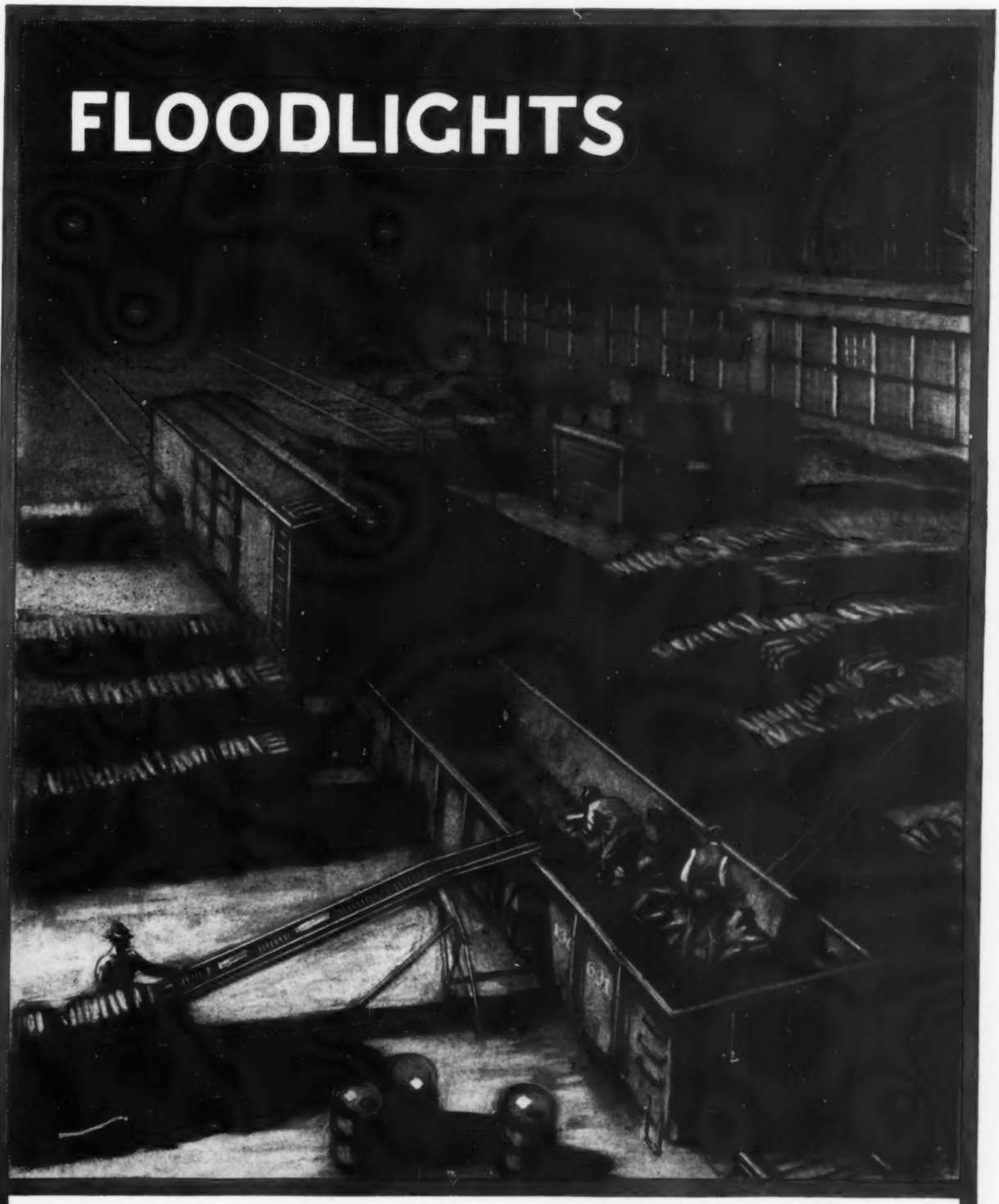


the steam trap with one moving part

AND this moving part *never* needs adjustment. The Johns-Manville Steam Trap has nothing that can get out of order or that requires periodic attention. Its action is as simple as its design. Install a few of "the simplest steam traps made" and cut the loss on your steam lines—and maintenance charges, too.

JOHNS-MANVILLE Inc.
292 Madison Ave., at 41st Street, New York City
Branches in all large cities
For Canada: Canadian Johns-Manville Co., Ltd., Toronto

JOHNS-MANVILLE Steam Trap



CROUSE-HINDS COMPANY

ESTABLISHED 1897

SYRACUSE, N. Y., U. S. A.

Sales Offices

NEW YORK
PHILADELPHIA DETROIT CLEVELAND
PITTSBURGH CINCINNATI ATLANTA

BOSTON

CHICAGO
ST. LOUIS MINNEAPOLIS
SAN FRANCISCO MILWAUKEE

CH 283

INDUSTRIES using electrical energy save 80% annually in fuse maintenance costs by installing Economy Renewable Fuses in the place of "one-time" fuses.

The famous Economy "Drop Out" Renewal Link—the least expensive and the only portion of the fuse destroyed in operation—makes this saving possible.

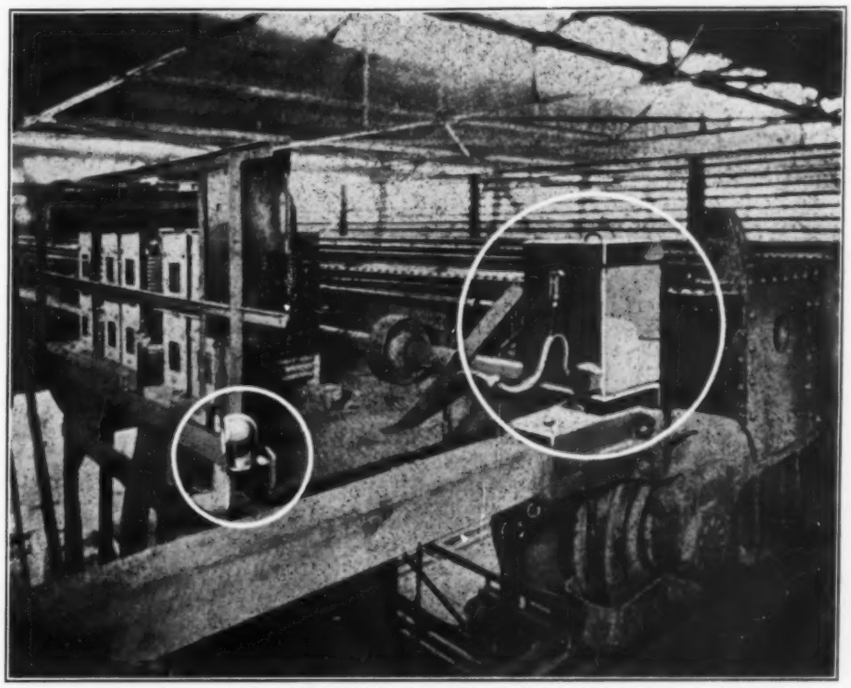
Check up your fuse costs.

For Sale by All Leading Electrical Jobbers and Dealers

ECONOMY FUSE & MFG. COMPANY
Chicago, U. S. A.

Economy Fuses were the first line using an inexpensive bare renewal link for restoring a blown fuse to its original efficency to be Approved in All Capacities by the Underwriters' Laboratories.

ECONOMY *renewable* FUSES

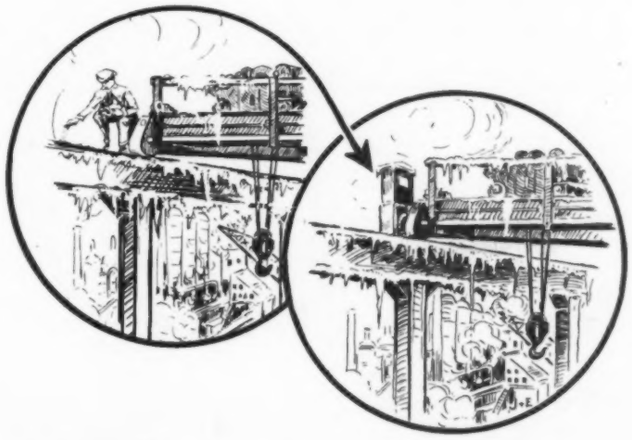


They Don't Use Human Sanders Any More

The operator of this crane at the Youngstown Sheet & Tube Co. is human. He doesn't like to take chances. And his company doesn't ask him to. They've equipped his crane with Lintern Electro-Magnetic Sanders to keep him off the runways. He sands the rail ***from his cab,*** without an instant's loss of working time. And he's less liable to "lay up" for repairs due to skids and strains. For him, Winter's icy days hold no fears. Yes, he's human, and he does better work because he has a better crane to work with.

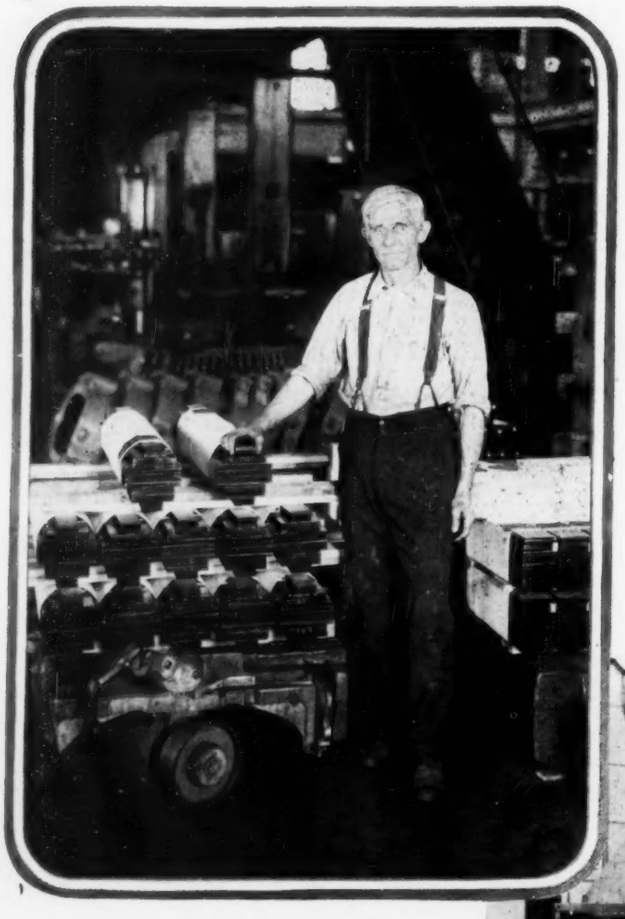
THE NICHOLS-LINTERN CO.
7960 LORAIN AVENUE CLEVELAND, OHIO

In Your Plant This Winter—



This —— or this?

Noah Knows Transformer Cores



Noah Genger with some of his cores.

Noah Genger celebrated the silver anniversary of his service with The Packard Electric Company five years ago.

For thirty years he has been cutting and treating core steel—for many years he has been in charge of the core department.

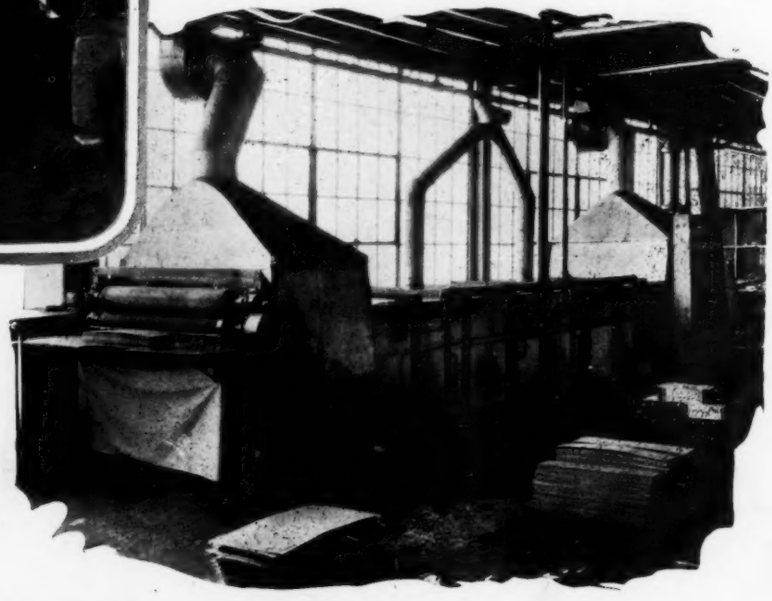
His practical knowledge and experience in handling core steel makes his judgment invaluable.

He is a living assurance that the cores of Packard Transformers are right—exactly according to design—perfectly made and treated.

The seasoned experience, the time-tried loyalty of men like Noah Genger is that "priceless ingredient" which means so much to the buyer.

It is impossible to over-estimate the part played by these men in giving to Packard Transformers the "Honest Value" for which they are known.

Noah Genger is one. There are many others.



Core treating tanks and ovens.

The Packard Electric Company

Offices in Principal Cities

WARREN, OHIO

Packard is never seen, except on goods of honest value

TECHNOLOGY DEPT.

Engineering Progress

FUEL — ELECTRICITY — MACHINERY — METHODS

EMPIRE BUILDING, PITTSBURGH, PA.

To Educate the Engineer in Industry

INSPECTION TRIP

Reading Shops

READING, PA.

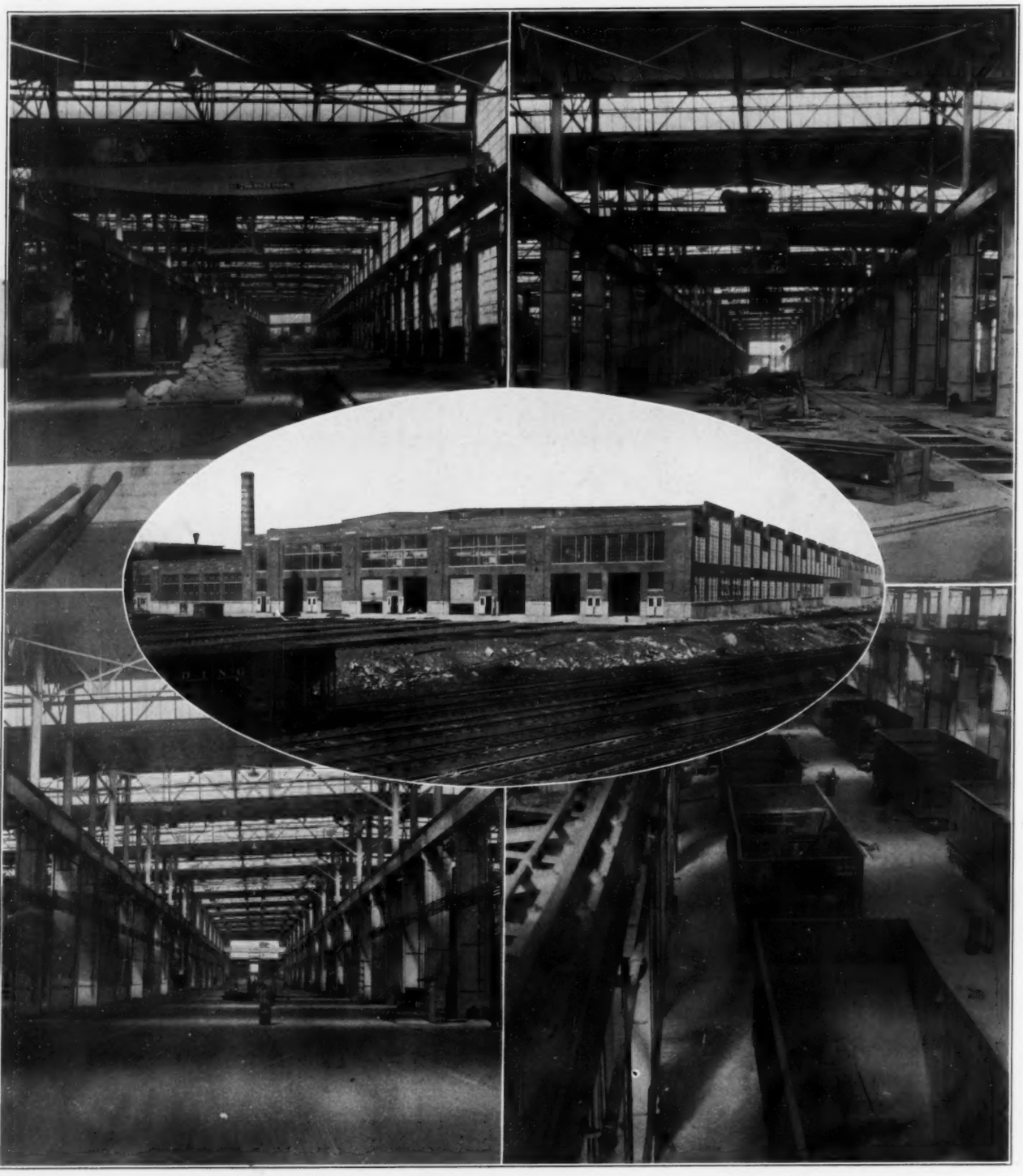
Containing the Program of the Reading Meeting

December 10, 1926

Office Supt. Motive Power and Rolling Equipment — New Car Repair Shop Office

Night View, New Car Repair Shop

An Invitation to Attend Our Trip to Reading Company's Locomotive and Car Repair Shops



New Car Repair Shop

Another View New Car Repair Shop

New Car Repair Shop, from Main Line of Railroad

Still Another View New Car Repair Shop

First Coal Cars Put in New Car Repair Shop for Repairs

Program

NATIONAL MEETING—ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS

READING, PA. DECEMBER, 10, 1926

Hotel Headquarters
AMERICAN HOUSE
4th & PENN STREETS

Meeting Headquarters
RAJAH TEMPLE
NORTH 6th STREET

Inspection Trip: Reading Company's Locomotive and Car Shops, 2.30 P. M.
Assemble at gate North 6th Street, between Robeson and Marion Streets.

Dinner: Rajah Temple at 6.00 P. M.

The paper of the evening will be: "The Maintenance of Locomotives and Rolling Equipment" to be given by Mr. I. A. Seiders, Supt. M. P. & R. E., Reading Company, at 7.30 P. M.

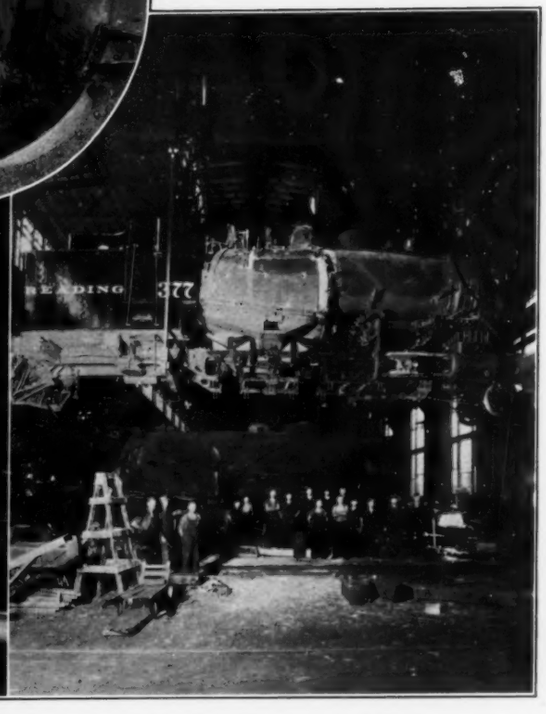
Synopsis:

The Company's Equipment and its Costs.
The Company's Shops and Engine Houses.
Working Force in the Mechanical Department.
Reading Locomotive Shop.
Repairing of Locomotives and Cars.
Welding.
Automatic Train Control.
Reading Shop Power Plant.
Reading Engine House.
New Reading Coaling Station.
Electrical Equipment in New Car Repair Shop.
New Car Repair Shop.

GEORGE H. SCHAEFFER
President

READING, PENNSYLVANIA

DECEMBER 10, 1926



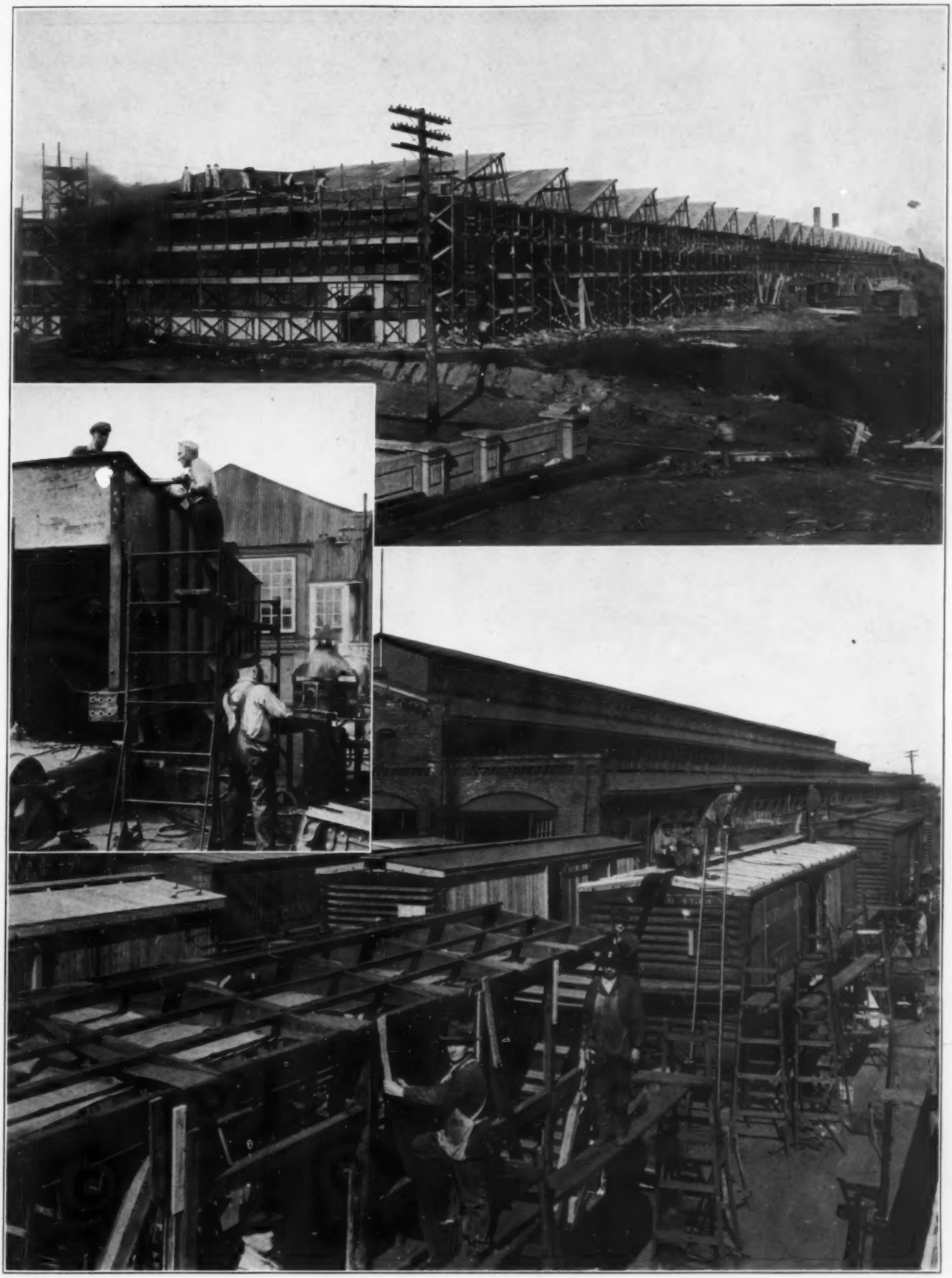
New Coaling Station and Ashes Pits

Locomotive, Front End

Locomotive Tire Shrinking

D. C. Generator, Power Plant

Method of Hoisting, Locomotive Shops



Steel Coal Car Repairing

New Passenger Car Paint Shop in Course of Erection

Box Car Repairing at Old Car Shop

Locomotive Tire Removing
Journal Truing
Machine Shop
Boring Cylinders
Tire Turning

Fire-Box Lagging
Thru the New Machine Shop
Thru the Erecting Shop
Balcony, New Machine Shop
Machine Section, Erecting Shop
Punching Fire-Box Sheet

The Boardwalk Flyer

Association of Iron and Steel Electrical Engineers

FOUNDED 1907

The object of the Association is the advancement of electricity and other branches of engineering to the Iron and Steel and Allied Industries through the co-operation of its members.

The principal engineering branches that the Association specializes on today are electrical, combustion, safety and mechanical.

The Association has for its members, presidents, executives, operating superintendents and all classes of engineers in the Iron and Steel and Allied Industries.

The Association represents twenty years of engineering service to the Iron and Steel and Allied Industries.

The Association of Iron and Steel Electrical Engineers operates five sections: Birmingham, Chicago, Cleveland, Philadelphia and Pittsburgh.

The Iron and Steel Engineer is the official periodical of the Association and is operated exclusively by the executives and engineers of the Iron and Steel Industry. As a reference and a guide in the Iron and Steel field, it is incomparable.

The Iron and Steel Exposition is an institution operated in connection with the Annual Convention of the Association of Iron and Steel Electrical Engineers. All of the leading manufacturers are represented at the Exposition. The Exposition will be held in June, 1927, at Pittsburgh, Pa.

The Association of Iron and Steel Electrical Engineers operates each year inspection trips to the leading Steel Companies of the United States. The following is a partial list of the Steel Companies who have co-operated with the Association:

THE ALAN WOOD IRON AND STEEL CO.,
Ivy Rock Plant, Ivy Rock, Penna.

AMERICAN STEEL & WIRE COMPANY,
Cleveland, Ohio.

BETHLEHEM STEEL CORPORATION,
Lehigh Division, Bethlehem Plant, Bethlehem, Penna.

Saucon Division, Bethlehem Plant, Bethlehem, Penna.

Steelton Plant, Steelton, Penna.

Maryland Plant, Sparrows Point, Md.

Cambria Plant, Johnstown, Pa.

Lackawanna Plant, Lackawanna, N. Y.

CARNEGIE STEEL COMPANY,
Clairton Steel Works and Furnaces, Clairton, Penna.

Clairton By-Product Coke Works, Clairton, Penna.

DUQUESNE STEEL WORKS AND FURNACES,
Duquesne, Penna.

EDGAR THOMSON STEEL WORKS AND FURNACES,
Braddock, Pa.

McDONALD MILLS,
McDonald, Ohio.

OHIO STEEL WORKS AND FURNACES,
Youngstown, Ohio.

CARPENTER STEEL COMPANY,
Reading, Penna.

CENTRAL STEEL & FURNACE COMPANY,
Massillon, Ohio.

DONNER STEEL COMPANY,
Buffalo, N. Y.

FORD MOTOR COMPANY,
Detroit, Mich.

HARRISBURG PIPE AND PIPE BENDING CO.,
Harrisburg, Penna.

ILLINOIS STEEL COMPANY,
Gary Works, Gary, Ind.

INLAND STEEL COMPANY,
Chicago, Ill.

LUKENS STEEL COMPANY,
Coatesville, Penna.

NATIONAL ENAMELING AND STAMPING CO.,
St. Louis, Mo.

NATIONAL TUBE COMPANY,
McKeesport, Pa.

TENNESSEE COAL, IRON & RAILROAD CO.,
Birmingham, Ala.

TRUMBULL STEEL COMPANY,
Warren, Ohio.

UNITED STATES STEEL CORPORATION,
Boat Ride up the Hudson River and Dinner at Bear Mountain, New York, N. Y.

YOUNGSTOWN SHEET AND TUBE COMPANY,
Youngstown, Ohio.

IRON and STEEL ENGINEER

FUEL — ELECTRICITY — MACHINERY — METHODS

EMPIRE BUILDING, PITTSBURGH, PA.

To Educate the Engineer in Industry

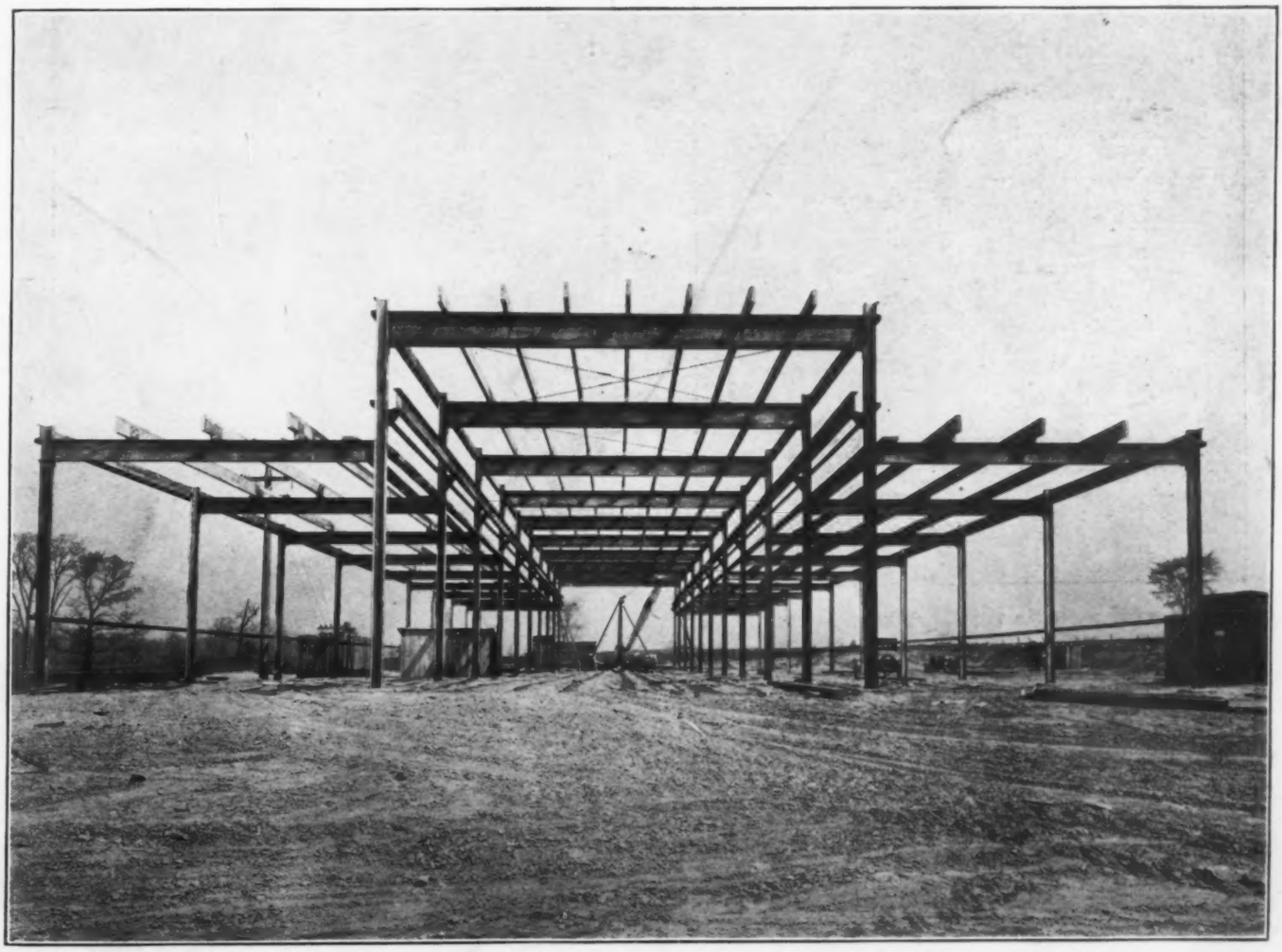
December 18th,

Pittsburgh, Pa.

Containing the Proceedings of the A.I.&S.E.E.

Arc Welded Structural Steel Buildings

By C. G. WATSON, General Manager,
Youngstown Welding Company,
Youngstown, Ohio



Arc elde
Structural Sel

Ball Room,
Wm. Penn Hotel,
Pittsburgh, Pa.

2:30 P. M.
Saturday
December 18th

One of the latest developments in Electrical Applications is the substitution of electrical welding for riveting in structural steel buildings.

A number of companies at the present time are not only busily engaged in research work in this connection, but are actually erecting buildings without the use of a single rivet. A very interesting example of this type of construction is the new shop of Youngstown Welding Company, which was built under the direction of Mr. C. G. Watson, the General Manager. Although Mr. Watson is an expert welder himself, he is also a structural engineer, so that, while this building was designed from an electric welder's point of view, and was erected by welders regularly employed by the company it was with the full knowledge of the building standards and requirements of riveted structures.

This new shop building, which is in the extreme western end of Youngstown, is of the most modern shop type. Its dimensions are about 80 feet wide and 200 feet long, with a central longitudinal crane runway. The girders for the traveling crane are beams welded to brackets of the gusset type, which are built of plates, and welded to the columns. Practically all the structural members used are beams.

In the construction of this building no special drawings were required nor was exact cutting asked of the mill. No extreme precision was required in the shop preparation of the steel, standard mill tolerances being accepted. Any differences that devel-

elded

Sel Buildings

6:00 P. M.
Turkey Dinner
Ball Room
Wm. Penn Hotel

6:00 P. M. to Midnight
Annual Christmas
Party in the Ball Room
of Wm. Penn Hotel

oped in dimensions were met either by an extra deposit of welding metal in welding, or by cutting extra material with the gas torch.

The entire building was fabricated and erected at the building site by skilled welding mechanics, who make electric welding their regular business, having been trained in the art of welding at least from four to five years.

This scheme of fabrication is so revolutionary in its character that it will have had to undergo all the trial and tribulations of all other electrical applications, beginning with the substitution of motor driven for steam driven units. It is expected, of course, that some opposition to this new process will have to be overcome, first, with the fabricators, then the architects, then the iron workers, and last the proper education of welding mechanics to perform this task successfully. Electric welding of structural steel buildings is here, it's here to stay. Its fundamentals are correct—it's economical—it's flexible—all that is required of it is safe and sane handling and development.

Mr. R. F. Chaffin, Electrical Superintendent, Pittsburgh Crucible Steel Company, Midland, Pa., and Chairman of the Pittsburgh Section of A. I. & S. E. E., will have charge of the meeting. He will be assisted by the executive committee of the Pittsburgh Section, consisting of F. E. Leahy, Power Engineer, National Tube Company, Pittsburgh, Pa.; C. S. Proudfoot, General Manager, United States Ferro Alloy Corporation, Buffalo, N. Y.; W. E. Miller, Electrical Superintendent, Bethlehem Steel Company, Johnstown, Pa.; R. B. Davenport, Electrical Superintendent, Carnegie Steel Company, New Castle, Pa., and John F. Kelly, Secretary.

A. I. & S. E. E.
ANNUAL CHRISTMAS PARTY

Saturday,
December 18th,
1926

Ball Room,
Wm. Penn Hotel,
Pittsburgh, Pa.

Tickets $5.00

Bring Along Your Friends